SERIAL NO. 242

REPORT OF SURVEY
FOR

FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK
SANTA CLARA AND SAN MATEO COUNTIES
CALIFORNIA

APPENDICES

JANUARY 1961

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
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APPENDIX A

HYDROLOGY

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APPENDIX A

HYDROLOGY

GENERAL

A-1. SCOPE AND DESCRIPTION

a. Scope. This appendix presents climatic and hydrologic data for the San Francisquito Creek Basin, California. It includes derivation of the standard project and probable maximum floods required for the design and evaluation of the proposed project, development of a discharge-frequency curve at Palo Alto, a regulation schedule for the proposed reservoir, and the effect of flood-control storage in reducing flood peaks.

b. Description. San Francisquito Creek drains a T-shaped area on the eastern slope of the Santa Cruz mountains at the southern extremity of the San Francisco Peninsula and is tributary to San Francisco Bay. Basin orientation is principally southeast and northwest, averaging about 12 miles in length and 3 miles in width. The effective drainage area of the basin is 38.4 square miles with a total area of 45 square miles including the area of the flood plain adjacent to the creek. The flood plain area drains away from the creek and does not contribute to channel flow.

c. Tributaries and topography. The principal tributaries are Los Trancos Creek, river mile 8.8, drainage area 8 square miles; Bear Creek, river mile 12.3, drainage area 11.8 square miles; and Corte Madera Creek, river mile 13.0, drainage area 7.8 square miles. The slope of San Francisquito Creek from river mile 0 to 5.8 is about 13 feet per mile increasing to 50 feet per mile in the next 4 miles. Slopes on tributaries vary from 50 to 100 feet per mile. As illustrated on Plate A-2, 35 percent of the basin area lies above elevation 1,000 m.s.l. datum with an average ridge elevation of about 2,000 feet above m.s.l. and a maximum of 2,650 feet above m.s.l. Stream profiles are shown on Plate A-1.

CLIMATOLOGY

A-2. CLIMATE

The San Francisquito Creek basin has the typical central California climatic pattern characterized by warm, dry summers and mild wet winters. The dominant influence is the position of the Pacific High Pressure Area. During the summer, the High is at its more northerly latitude and a northwest circulation of maritime air influences the climate. This air is stable and results in the typical advective coastal fogs caused by warm air passing over the cold Pacific water surface. During the winter the Pacific High migrates to more southerly latitudes and the passage of cyclones from the area of the Aleutian Low intermittently affects the California climate. The Pacific High also occasionally migrates to the north during the winter, resulting in relatively mild weather. Less frequently, a continental high pressure area will move over the western states resulting in cold, dry, continental air. Although this situation is relatively infrequent, it results in the low minimum temperatures noted over the basin. Average temperatures and extremes are tabulated in Table I for Palo Alto, California, near the mouth of the basin.

PRECIPITATION ANALYSES

A-3. PRECIPITATION

a. Precipitation stations and records. Records are available from 28 active and inactive precipitation stations within or adjacent to the basin. Locations of these stations are shown on Plate A-3 and pertinent data are shown on Table II. Thirteen stations are active, eleven having records in excess of 25 years. There are two recording precipitation gages adjacent to the basin, located on the Stanford University Campus and at the Palo Alto City Hall, respectively. Both are at low elevations near the mouth of the stream. Because of the lack of recording rainfall stations within the basin, it was necessary to use data from the Boulder Creek Locatelli Ranch gage located 13 miles south of the basin on the windward side of the ridge. This recorder is in an area of high rainfall and, therefore, more nearly represents the rainfall intensity patterns that occur at the higher elevations of San Francisquito Creek basin than do the Palo Alto or Stanford University recorders.

b. Expansion of data. To determine the probable long-term average annual precipitation at each station, station averages were adjusted to a common base period of 70 years, 1875-1945, by use of base stations having long periods of record. The base stations of San Andreas, Upper Crystal Spring, Lower Crystal Spring, and Rixford were used for the adjustment of stations at higher elevations or stations with an average annual precipitation exceeding 24 inches. The base stations of Mountain View, Santa Clara, San Jose, and Los Gatos were used for the stations of lower elevation and rainfall. The average annual precipitation for the central coastal region of California has been recalculated recently on the basis of the 50-year period, 1907-1956, in connection with a study of the San Francisco Bay. This new base period indicated an adjusted average station precipitation of eight percent less than obtained in this report, and would have no appreciable effect on the standard project flood as derived in this study.

c. Seasonal and areal distribution of precipitation. Approximately 90 percent of the seasonal rainfall occurs from October through March (see Table I). The basin topography has a pronounced effect on total seasonal rainfall and its distribution over the basin. The heaviest rainfall occurs at the higher elevations due to carry-over effect from the rapid orographic lifting of the air mass on the windward side of the barrier. Since the major axis of the basin is parallel to this barrier, average annual precipitation is relatively high. Average annual precipitation amounts decrease from more than 44 inches at the ridge to 16 inches near the mouth. Plates A-3, and A-5 illustrate the influence of the orographic barrier on storm and seasonal rainfall. The average annual rainfall is about 32 inches over the entire basin and about 36 inches for the drainage basin above the proposed damsite.

A-4. STORM ANALYSIS

a. Storm characteristics. Flood producing storms are caused by the formation of a tight-pressure gradient between the prevailing North Pacific low-pressure area and the Pacific high-pressure area to the south, causing waves forming on the resulting frontal barrier to move over the area at a high velocity, with semi-tropical air in the warm sectors. Major storms have varied in duration from one to several days. Periods of high intensity rainfall of relatively short duration during such storms causes discharges of flood magnitude. Flood peaks occur at the lower end of the basin about three or four hours after the most intense part of a storm. Storms of a recurrent nature have occurred for durations in excess of three days, but have contained periods of little or no rainfall, allowing runoff to recede. Storms separated from subsequent storms by more than 12 hours or no rainfall have little effect on subsequent discharges. Mass rainfall curves, Plate A-4, show the total depth of rainfall and indicate the rainfall intensity during four major storms of recent years at selected precipitation stations.

b. Notable storms of record. Available rainfall records for stations at Rixford, Palo Alto, Searsville and Ben Lomond indicate there have been a number of flood producing storms since 1884. Major storms as recorded at representative stations, in or adjacent to the basin, are tabulated in Table IV. Of these storms, 11-14 January 1911 and 21-24 December 1955 were the most severe. Data for the storm of 4 January 1895 are limited to the station at Rixford where 4.04 inches of rainfall was recorded, and is the maximum daily total of record for this station during the period 1884-1938.

A-5. STANDARD PROJECT STORM

a. Definition. The standard project storm may be defined as the most severe storm of record within a more or less meteorologically homogenous region in which the basin under study is located. The region in which San Francisquito Creek basin is located is delineated in Plate A-8. The most severe storm after adjustment for transposition over the subject basin has been adopted as the standard project storm from which the standard project flood is derived.

b. Determination. Major storms of record within the specified region were studied with the aid of isopercentual maps, with storm rainfall expressed as a percentage of adjusted average annual precipitation. A depth-area curve was developed from these maps by determining the area inclosed by adjacent isopercentual lines about the maximum storm center. The transposed average storm depth in percent of average annual precipitation for San Francisquito Creek basin was determined by use of this curve. The two most critical storms of record in the central region occurred 9-12 December 1937 and 21-24 December 1955. The transposed storm depths for these two storms adjusted by the basin average annual precipitation above the U.S. Geological Survey stream-gaging station at Stanford University (drainage area 37.5 square miles) are 16.24 and 17.22 inches, respectively. Precipitation distributions during the storms were based on recording gages near the storm centers. Of these two storms, the 21-24 December 1955 storm resulted in the greater peak discharge and volume of flood runoff for San Francisquito Creek basin, and was therefore adopted as the standard project storm. The recording precipitation stations of Hollister, Stayton Mine, and Freedom 8 NNW were used to distribute the storm rainfall. The locations of these three stations with respect to the storm center are shown on the isopercentual map, Plate A-8. The adopted hyetograph is shown on Plate A-9. The December 1955 storm as it actually occurred over the basin, compared with the transposed depth, is 0.78 inches to 1.21 inches during the maximum hour and 2.70 inches to 4.98 inches during the maximum six-hour period.

A-6. PROBABLE MAXIMUM STORM

Estimated probable maximum precipitation for the basin above the proposed damsite (drainage area 28 square miles) was prepared by the Hydrometeorological Section of the U.S. Weather Bureau. This storm was based upon a premise of optimum meteorological conditions of dew point, air moisture, wind velocity and wind direction. The adopted depth-duration curve envelops estimates based on two principal procedures: (1) maximizing the Hoberg's Resort December 1957 storm center for winds and moisture content and transposing to the subject basin, (2) adjustment of the December 1955 Los Gatos 5W observed point rainfall to a 28-square mile area at maximum moisture content. The U.S. Weather Bureau compared this curve with estimates obtained by transposition without barrier depletion effect of the maximum observed United States precipitation, adjusted to a reduced 12-hour enveloping dew point of 65°F. The depth-duration curve having a probable maximum 24-hour value of 21.2 inches is shown on Plate A-10.

RUNOFF AND STREAMFLOW

A-7. STREAM-GAGING STATIONS AND RECORDS

Records are available at five discontinued and one active recording stream-gaging station within the San Francisquito Creek basin. These records cover the periods 1931-41 and 1950 to date. The locations, period of record, maximum stage and discharge of record, and drainage area are shown in Table III and Plate A-3. In addition to these stations, staff-gage records maintained at the Searsville Lake wasteway weir for the period 1892-1913 were useful in estimating the annual maximum discharge for those years. The flood of 21-24 December 1955 is the maximum since the recording stream gage program was initiated in the basin in 1931.

A-8. MAJOR FLOODS

From newspaper accounts, information obtained from local residents and by correlation with staff readings at Searsville Lake, it appears that six major floods occurred between 1892 and the initiation of a gaging program in 1931. These occurred during February 1894, January 1895, January 1909, January 1911, January 1916 and February 1919. Five floods have occurred since 1931 as follows: February 1940, January 1943, November 1950, December 1955 and April 1958.

A-9. UNIT HYDROGRAPH DEVELOPMENT

a. Derivation. The two-hour unit hydrograph shown on Plate A-5 was derived from rainfall and hydrograph records from the 21-24 December 1955 flood by trial reproduction of the gage hydrograph. The unit hydrograph then was corroborated by reproduction of the 14 January 1952 discharge hydrograph. The peak flow for 14 January 1952 is of minor magnitude and the reproduced peak using the unit hydrograph derived from the December 1955 flood exceeds the gaged peak as would be expected. Hydrograph reproductions by use of the adopted unit graph are shown on Plates A-5 and A-6.

b. Upstream storage. Searsville Lake is the only reservoir located within the watershed of San Francisquito Creek. It is located at river mile 12.7, has a drainage area of 14.8 square miles, and a maximum storage of approximately 950 acre-feet. This reservoir has an uncontrolled spillway which produces little reduction in flood peak discharges, however, its effect is reflected in the adopted unit hydrograph as the reservoir fills early in the flood season. Irrigation and domestic diversions are made above the gaging station, but have no significant influence on flood peak discharges, as diversions are made primarily during times of moderate flow when silt content is at a minimum and diversions are more easily controlled. Maximum instantaneous diversions average about 75 to 100 c.f.s. with a total annual volume of approximately 7,000 acre-feet.

c. Unit hydrograph characteristics. Unit hydrograph and basin characteristics were determined and plotted with characteristics of other streams in the central California coastal and Bay Area to derive unit hydrographs for Los Trancos Creek and inflow to the proposed dam. No gaged hydrographs exist for inflow to the proposed reservoir. Records are available for a 7.6-square mile area of Los Trancos Creek for the period, 1931-1941. The greatest discharge during this period was 647 c.f.s. on 27 February 1940; this discharge was too low to provide representative hydrograph characteristics for major floods. A unit hydrograph for the 10-square mile area above the gaging station at Stanford University includes the Los Trancos Creek drainage area and local inflow below the proposed dam. This unit hydrograph was determined from basin characteristics and is considered as reliable as using the gaged hydrograph of February 1940. Basin characteristics used were: length of longest water course, length of longest water course to a point opposite the center of area, the overall slope of basin, and the drainage area. Unit hydrograph characteristics used were: time of lag, defined as the time required for the graph of accumulated flow to reach fifty percent of the ultimate value, and the general shape of the accumulation graph (S-graph) expressed in dimensionless form. Unit hydrograph characteristics are shown on Plate A-7 and unit hydrograph ordinates are tabulated in Table VI.

A-10. STANDARD PROJECT FLOOD

The standard project flood is the hypothetical flood estimated to result from the occurrence of the standard project storm over the basin when antecedent rainfall has created conditions reasonably favorable to runoff. Since the storm of 21-24 December 1955 was preceded by a three-week period of intermittent rainfall, it is considered to be representative of watershed conditions favorable to runoff. Apparent loss rates starting at 0.28-inch per hour, and lowering to 0.06-inch per hour, as determined from the storm of 21-24 December 1955, were adopted for application to the standard project storm. Adopted hydrographs of the standard project flood are shown on Plate A-9. The report, "Standard Project Flood, San Francisquito Creek, California", was submitted to the Chief of Engineers with letter dated 5 November 1956, subject: "Report of Standard Project Flood on San Francisquito Creek, California", and was approved by second indorsement thereon dated 25 January 1957. The standard project flood discharge downstream from the stream-gaging station at Stanford University is 13,800 c.f.s. A peak discharge of

11,000 c.f.s. was credited to reservoir inflow. The peak discharge for the remaining 10-square mile area including Los Trancos Creek and intervening flow between the damsite and the stream gage at Stanford University was determined to be 2,900 c.f.s. Los Trancos Creek peaks before the remaining part of San Francisquito Creek basin and accounts for the combined peak being less than the sum of tributary peak discharges. No significant inflow to the creek occurs below this gage.

A-11. MAXIMUM PROBABLE FLOOD

The maximum probable flood inflow to the proposed reservoir was developed from the depth-duration curve of probable maximum precipitation discussed in paragraph A-6. As suggested by the Weather Bureau, the hourly increments were distributed symmetrically before and after the largest increment. This arrangement postulates a normal increase and decrease of the variables in the rain producing mechanism. An initial loss rate of 0.20-inch per hour decreasing to 0.06-inch per hour was used with a one-hour unit hydrograph modified to reflect an intense concentration of runoff. The hydrograph of probable maximum reservoir inflow with a peak of 27,000 c.f.s. is shown on Plate A-10 and was used to determine spillway design requirements.

A-12. DISCHARGE FREQUENCY ANALYSIS

Records of streamflow are available on San Francisquito Creek for the 19-year period 1931-41, 1951-58. Annual maximum discharges for the 9-year period, 1942-50, were estimated by analytical correlation with San Lorenzo River at Big Trees using 12 years of coincident record having a correlation coefficient of 0.95. A frequency analysis of annual peak discharges during the total period, 1931-58, was made by analytical methods outlined in "Statistical Methods in Hydrology", July 1952, by Leo R. Beard, referred to in EM 1110-2-1450, paragraph 2a. In an effort to increase the reliability of the analysis, the period of estimated annual maximum discharges was extended to 1893 by estimates made from stage records of discharges over the Searsville Dam wasteway weir (14.8 square miles) for the 19-year period, 1893-1911, and by correlation with Palo Alto rainfall records during the 19-year period, 1912-1930. A frequency analysis was made based on this long-term series using the method employed in analyzing the shorter series. The estimated and gaged annual maximum discharge series statistics for San Francisquito Creek at Palo Alto are tabulated in Table V for present conditions and with estimated reduced peaks due to regulation by the proposed dam and reservoir. Upon recommendation of the Chief of Engineers following preliminary review of the adopted frequency curve, two additional methods were used as a means of evaluating the reliability of the results obtained from analysis of the estimated long-term series:

(1) An analytical correlation of annual peak discharges during 19 years of coincident record for Arroyo Seco near Soledad (located 100 miles southeast of San Francisquito Creek in the Salinas River basin) was extended on the basis of statistics computed for the total period of record at Soledad, 1902-58. The coefficient of correlation for the 19-year period of coincident record is 0.90. The mean and standard deviation required only minor adjustment from the short term to long term period. The adjusted statistics are considered equivalent to 50 years of record on San Francisquito Creek. The analysis with Arroyo Seco agreed well with the long-term estimates for San Francisquito Creek with a 6 percent smaller mean and 2 percent smaller standard deviation.

(2) A second but generally less reliable method is outlined in CW-151, Technical Bulletin No. 3, "Flood Volume Frequency for Pacific Coast Streams", U.S. Army Corps of Engineers, Sacramento District, 28 March 1956, and CW-151, Technical Bulletin No. 2, "Coordination of Flood Volume Frequency Statistics". This method correlates streamflow characteristics with normal annual rainfall and basin characteristics of slope, size, stream length, etc., and is intended for use on basins having no stream-gaging records. Average regression constants, reflecting an average of all west coast streams analyzed in CW-151 were used since CW-151 does not include any group of streams more nearly representative of the subject basin than Arroyo Seco. Bulletin No. 3 concludes that the reliability of this procedure is statistically equivalent to determining the 2-year event from 4 years of record or the 100-year event from 10 years of record. The mean discharge obtained from basin characteristic correlation analysis was 12 percent below the mean for the 1893-1958 series with a standard deviation about 2 percent less than that obtained from the long term series.

A-13. The frequency curve based on the 1893-1958 gaged and estimated series is shown on Plate A-12 for present and project conditions. A slight negative skew was adopted in the final curve as both the San Francisquito Creek data and the 57-year record on Arroyo Seco indicate this trend. The curve indicates that the 22 December 1955 flood discharge would be equalled or exceeded on the average of about five times in a 100-year period. No reliable estimate of historical floods prior to the estimated series beginning in 1893 can be made, although there is some evidence of major floods during the season 1862 and 1890 which indicate that the December 1955 flood was probably the fourth largest event in the past 100 years.

RESERVOIRS

A-14. PLAN OF IMPROVEMENT

Various plans of improvement were studied. These included channel improvement, levees, reservoir storage, and combinations of the three.

The most economical solution proved to be control by reservoir storage. It is estimated that bankfull capacity of San Francisquito Creek in the reach from river mile 2.0 downstream to Bayshore Highway is 3,000 c.f.s. Channel capacity at upstream points is greater. Minor bank erosion occurs at discharges in excess of about 1,500 c.f.s.

A-15. SEDIMENTATION

Depletion of storage capacity in the proposed reservoir by siltation is an important factor. The U.S. Geological Survey is conducting a sediment measurement program for the Corps of Engineers including San Francisquito Creek as one of the sampling sites. Computations, based on 1956-58 suspended sediment measurements and seven years of streamflow records, resulted in a factor of 0.62-acre-foot per year per square mile drainage area. This period of measurement occurred during a period when the runoff was 1.7 times normal. Based on this analysis, a factor of 0.4-acre-foot per year per square mile drainage area has been adopted. This would require a reservation of 600 acre-feet during the adopted 50-year economic life of the project. This total was equally divided between the water conservation and flood control space.

A-16. STORAGE REQUIREMENTS

a. Flood control storage. Terrain and high acquisition costs of residential properties limit the crest elevation of dam to about 300 feet m.s.l. An analysis of storage allocation for water conservation, flood control and siltation indicates the most desirable allocation for flood control to be 8,500 acre-feet. A minimum storage of 12,000 acre-feet would be required to limit the standard project flood to 3,000 c.f.s. downstream from Los Trancos Creek. The effect of the proposed flood control storage on gaged and synthesized floods is shown on Plates A-5, A-6, A-9 and A-10. The provision of 8,500 acre-feet of flood control storage would have controlled all historical floods including the flood of 8-15 January 1911, which is believed to be the most critical multiple-flood during the period 1850 to date. Assuming December 1955 runoff and channel conditions, it is estimated that the 1911 flood would have required 6,000 acre-feet of flood control storage. The flood of 21-24 December 1955 with a peak discharge of 5,560 c.f.s. could have been reduced to bankfull discharge with 1,000 acre-feet of flood control storage and outlet works having a minimum capacity of 2,500 c.f.s. Under the proposed design providing an uncontrolled outlet with 2,000 c.f.s. capacity when the water surface is at the spillway crest, the required flood control storage for the 21-24 December 1955 flood would have been 4,000 acre-feet. The hydrograph of the largest flood which would be fully controlled by 8,500 acre-feet of storage is shown on Plate A-10 and is equivalent to 68 percent of the standard project flood. The maximum instantaneous inflow for the reservoir design flood as computed is 7,500 c.f.s. with a maximum routed outflow of 2,000 c.f.s. and a downstream maximum discharge of 3,000 c.f.s.

b. Adopted storage and elevations. The proposed reservoir is designed to provide 12,600 acre-feet of storage including 8,500 acre-feet for flood control, 600 acre-feet for siltation and 3,500 acre-feet for water conservation. Pertinent elevations are as follows:

Top of water conservation pool	Elevation	258	ft.	m.s.l.
Bottom of flood control pool	"	258	"	"
Spillway crest	"	289	"	"
Top of flood control pool	"	289	"	"
Maximum water surface, spillway design flood	"	297	"	"
Top of dam	"	302	"	"

A-17. RESERVOIR REGULATION ANALYSIS

Consideration was given to various types of outlet works; i.e., gated spillway, gated conduit, and ungated conduit. The greatest flexibility in control could be obtained from a gated outlet works; however, the most practical method was determined to be by means of a high level ungated conduit through the spillway section. The conduit is designed to pass 2,000 c.f.s. when the flood control pool is full. This design will afford a simple operation procedure and would not require permanent operating personnel. Flood runoff is too rapid to forecast inflow from recorded rainfall. The adopted design will require a slightly longer time to empty the flood control space than if a gated spillway or low level gated conduit were used; however, the water conservation outlet works provides a capacity of about 400 c.f.s. at the bottom of the flood control pool. Provisions can be made to utilize this feature during certain stages of the reservoir operation.

A-18. REDUCTION IN FLOOD PEAKS

Recorded and hypothetical flood hydrographs were routed through the proposed reservoir and outlet works to determine the flood peak reduction obtained from the adopted plan of improvement. From this analysis an average reduction curve was constructed and applied to the present conditions' frequency curve to obtain an estimated project conditions' frequency curve. The average reduction obtained downstream from Los Trancos Creek is shown on Plate A-12. Reduction in flood peaks of the December 1955, Reservoir Design Standard Project, and Spillway Design Flood are as follows:

DISCHARGE DOWNSTREAM OF LOS TRANCOS CREEK

	Present Conditions (c.f.s.)	Project Conditions (c.f.s.)	Reduction (c.f.s.)
December 1955	5,560	2,000	3,600
Reservoir design flood	9,400	3,000	6,400
Standard project flood	13,800	6,500	7,300
Probable maximum flood	27,000*	20,300*	6,700*

*At damsite

Table V lists the estimated and gaged annual maximum discharges under present and project conditions. The reduction shown in the above tabulation and in Plate A-11 for the probable maximum flood is based on the assumption that the flood control pool would be empty at the beginning of runoff. This assumption appears realistic since the outlet works is ungated and with proper design of trash racks, malfunctions are improbable. The flood control space would be empty within three to four days after the standard project storm, depending on the use made of the water conservation outlet. If the flood control pool were assumed full at the beginning of the spillway design flood, the maximum water surface would be one foot higher and the combined outflow from the ungated conduit and broad-crested spillway would be increased to 25,000 c.f.s.

A-19. HYDROLOGIC NETWORK

The proposed design will not require forecasting of reservoir inflow. There is need for short-duration rainfall data in the basin to aid in future hydrologic studies and evaluations. The proposed hydrologic network will consist of a recording rainfall gage located in the vicinity of the west ridge of the basin, a reservoir stage recorder, and continuation of the recording stream-gaging station below the confluence of Los Trancos Creek.

TABLE I

CLIMATOLOGICAL DATA

PALO ALTO, SANTA CLARA COUNTY, CALIFORNIA
Latitude 37°26'40" N., Longitude 122°08'16" W.
Elevation 23 feet m.s.l.

	Temperature					Precipitation Summary			
Month	Highest	Mean daily maximum	Mean daily	Mean daily minimum	Lowest	Greatest monthly	Mean precipitation	Least monthly	Greatest daily
Jan.	75	55.8	46.6	37.3	20	15.25	3.28	0.13	1.50
Feb.	79	59.7	50.0	40.0	25	7.94	3.04	0.23	1.75
Mar.	84	63.8	53.2	42.7	30	5.67	2.13	T	1.75
Apr.	91	67.5	56.2	45.0	31	3.49	0.97	0	1.05
May	97	71.9	60.0	48.0	36	3.00	0.47	0	0.84
June	102	76.4	63.9	51.4	40	1.17	0.13	0	0.48
July	105	77.8	65.6	53.4	44	0.19	0.01	0	0.19
Aug.	100	76.7	65.0	53.3	44	0.41	0.03	0	0.34
Sept.	103	76.8	64.0	51.4	39	5.55	0.25	0	0.82
Oct.	95	71.9	59.9	47.7	32	3.01	0.74	0	1.20
Nov.	84	64.7	53.3	41.9	26	5.70	1.48	T	2.56
Dec.	75	56.9	47.9	39.0	22	10.53	2.93	0.22	2.77
Annual	105	68.3	57.1	46.0	20	15.24	15.46	0	2.77

NORMAL SEASONAL PRECIPITATION DISTRIBUTION
(in percent of seasonal total)

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
0.1	0.2	1.6	4.8	9.6	18.9	21.2	19.7	13.8	6.3

May	June	Season
3.0	0.8	100.0

TABLE II

PRECIPITATION STATIONS IN OR NEAR SAN FRANCISQUITO CREEK BASIN

Map No. Fig. 4	Station	Location				Super vision 2/	Period of record	Elevation m.s.l.	Avg Annual precipitation 1/
		Latitude		Longitude					
		Deg.	Min.	Deg.	Min.				
1	Alpine Road	37	21.4	122	12.9	S.U.	1931-42	900	35.0
2	Bear Gulch Reservoir	37	25.8	122	13.8	CWS	1919-*	230	22.5
3	Black Mountain	37	19.6	122	10.1	S.U.	1930-42	2,350	26.4
4	Black Mountain, Los Altos	37	19.0	122	09.0	USWB	1942-54	2,620	39.2
5	Black Mountain, 2S	37	17.0	122	09.0	USWB	1954-*	2,330	36.3
6	Eastmen (Phlegar) Estate	37	27.3	122	18.0	Pvt.	1930-*	700	35.3
7	Felt Lake	37	23.6	122	11.3	S.U.	1930-42	400	19.5
8	Filoli	37	28.2	122	18.6	Pvt.	1921-45	350	33.5
9	Fitzhugh	37	22.1	122	13.0	S.U.	1932-35	610	27.5
10	Highway Maintenance Station	37	23.4	122	16.4	DH, SC	1930-42	1,400	41.5
11	Jackling	37	25.6	122	15.6	S.U.	1924-*	380	33.7
12	Kings Mountain	37	24.6	122	18.3	S.U.	1930-35	2,400	42.7
13	Kings Mountain Rd.	37	25.6	122	18.3	S.U.	1931-42	1,400	47.8
14	Mayfield, A & B	37	25.7	122	08.6	Pvt.	1906-07 1913-18 1935-41	31	15.3
15	Menlo Park, A	37	27.3	122	10.9	SPRR	1878-1918	64	16.4
16	Neylan (Law) Estate	37	21.3	122	14.2	Pvt.	1944-50	1,500	-
17	Palo Alto, A	37	26.6	122	09.8	SPRR	1906-18	60	16.5
18	Palo Alto City Hall (R)	37	26.6	122	09.8	USWB	1911-*	23	16.5
19	Rapley Ranch	37	22.5	122	15.1	Pvt.	1935-44	1,200	42.3
20	Rayner	37	23.1	122	15.7	S.U.	1930-42	1,450	37.5
21	Redwood City	37	28.0	122	14.0	USWB	1907-18 1930-*	31	20.5
22	Rixford	37	25.9	122	15.4	Pvt.	1884-1938	450	26.0
23	Rolph	37	20.1	122	11.4	S.U.	1931-49	1,650	37.5
24	Searsville	37	24.0	122	14.0	USWB	1925-*	350	29.5
25	Schilling	37	23.8	122	14.9	Pvt.	1930-*	400	35.9
26	Skylonda Fire Station	37	23.2	122	15.9	SM Co.	1950-*	1,480	41.5
27	Skyline Highway	37	19.4	122	11.8	S.U.	1930-42	2,200	37.5
28	Stanford Corp Yard	37	25.5	122	10.2	S.U.	1930-*	115	17.5
29	Stanford University (R)	37	25.8	122	10.2	S.U.	1952-*	90	-
30	Summer Ranch	37	19.9	122	13.5	Pvt.	1936-44	1,900	43.9
31	Woodside (Bear Gulch Cottage)	37	24.6	122	16.4	CWS	1925-*	600	40.5

TABLE II
(continued)

Station	Location		Supervision 2/	Period of Record	Elevation m.s.l.	Avg Annual precipitation 1/
	Latitude	Longitude				
	OTHER PRECIPITATION STATIONS REFERRED TO:					
Ben Lomond (R)	37 05.0	122 06.0	USWB	1937-**	500	52.0
Boulder Creek Locatelli (R)	37 08.0	122 12.0	USWB	1940-*	2,200	53.6
Freedom * NNW (R)	37 03.1	121 48.6	USWB	1952-*	1,495	40.5
Hayward (R)	37 38.9	121 58.1	USWB	1940-*	1,000	26.5
Hobergs	38 50.6	122 43.5	USWB	1930-*	3,000	58.6
Hollister #2 (R)	36 51.2	121 24.3	USWB	1938-*	295	12.3
Highland (R)	37 02.9	121 48.4	USWB	1937-52	1,350	40.5
Los Gatos	37 14	121 58	USWB	1906-*	500	28.9
Lower Crystal Springs	37 31.7	122 21.8	SFWD	1888-*	300	26.7
Mountain View	37 23.7	122 04.6	Pvt.	1909-*	75	14.7
San Andreas Lake	37 34.8	122 24.3	SFWD	1868-*	377	31.2
San Jose (R)	37 20.0	121 54.0	USWB	1906-*	95	14.4
Santa Clara	37 20.9	121 56.4	USWB	1903-*	88	14.6
Stayton Mine (R)	36 55	121 14	USWB	1939-*	2,975	23.3
Upper Crystal Springs	37 30.5	122 21.2	SFWD	1875-*	300	26.0

Notes: (R) Recorder.
* Active to date.
** Recorder 1937-50.
1/ Average annual rainfall adjusted to common 70-year base period 1875-1945.
2/ CWS - California Water Service.
DH, SC - Division of Highways, State of California
SPRR - Southern Pacific Railroad
S.M. Co. - San Mateo County.
S.U. - Stanford University.
SFWD - San Francisco Water Department.
USWB - U. S. Weather Bureau.

TABLE III

STREAM GAGING STATIONS AND RECORD
SAN FRANCISQUITO CREEK BASIN

Map index No. Fig.	Station	Drainage area (sq.mi.)	Period of record	Location				Stage (ft.)	Discharge c.f.s.	Date
				Latitude		Longitude				
				Deg.	Min.	Deg.	Min.			
1	San Francisquito Creek at Palo Alto	38.4	1931-41	37	27.2	122	08.3	17.22	3,100	27 Feb. 1940
2	San Francisquito Creek at Menlo Park	38.3	1934-36	37	26.6	122	10.5	10.05	1,610	21 Feb. 1936
3	San Francisquito Creek at Stanford University	37.5	1931-41 1950 to date	37	25.3	122	11.4	13.6	5,560	22 Dec. 1955
4	Los Trancos at Stanford University	7.6	1931-41	37	24.6	122	11.6	4.07	647	27 Feb. 1940
5	Los Trancos Canal near Stanford University	-	1931-41	37	33.3	122	11.2	-	42 s.f.d.	10 Jan. 1940
6	Lagunitas Canal at Stanford University	-	1931-41	37	25.1	122	11.3	-	23 s.f.d.	13 Feb. 1946

TABLE IV

MAJOR STORMS OF RECORD
SAN FRANCISQUITO CREEK BASIN AND VICINITY
(in order of Storm Magnitude)

Station	Observed Time	Date	24-Hour Rainfall Amount				Total
Ben Lomond	5 p.m.	11-14 Jan.	2.73	2.45	7.15	1.77	16.10
Palo Alto	5 p.m.	1911	0.48	2.15	2.25	3.42	8.30
Ben Lomond	5 p.m.	21-24 Dec.	1.69	4.86	10.42	0.74	17.71
Palo Alto	8 a.m.	1955	0.14	2.77	1.84	0.12	4.87
Searsville Lake	8 a.m.		0.20	2.80	4.75	1.64	9.39
Skylonda Fire Station	8 a.m.		0.91	5.27	6.72	0.42	13.32
Ben Lomond	5 p.m.	16-19 Nov.	4.00	2.42	7.10	3.92	17.44
Palo Alto	8 a.m.	1950	0.45	0.56	1.09	2.56	4.66
Searsville Lake	8 a.m.		0.83	0.84	1.88	2.73	10.28
Ben Lomond	5 p.m.	10-12 Dec.	8.15	4.00	0.64		12.79
Highway Maint. Station	8 a.m.	1937	4.47	2.82	0.44		7.73
Palo Alto	5 p.m.		1.78	1.15	0.53		3.46
Searsville Lake	8 a.m.		3.45	3.25	0.85		7.55
Stanford Corp. Yard	8 a.m.		1.94	1.48	0.67		4.12
Ben Lomond	8 a.m.	26-29 Feb.	1.10	6.25	4.47	0.82	12.64
Highway Maint. Station	8 a.m.	1940	0.83	3.30	*	2.05	6.18
Palo Alto	8 a.m.		0.41	1.54	1.48	1.00	4.42
Searsville Lake	8 a.m.		0.30	2.35	2.10	1.20	5.95
Stanford Corp. Yard	8 a.m.		0.45	1.73	1.63	1.16	4.97
Ben Lomond	5 p.m.	20-23 Jan.	4.36	6.73	0.73	2.51	14.33
Palo Alto	Midnight	1943	0.80	2.15	1.35	0.07	4.37
Ben Lomond	8 a.m.	22-25 Jan.	1.46	0.46	6.64	3.06	11.73
Palo Alto	8 a.m.	1942	0.42	0.07	1.64	0.51	2.64
Searsville Lake	8 a.m.		0.72	0.20	2.00	1.27	4.19
Ben Lomond	5 p.m.	11-14 Jan.	2.00	6.30	0.55	3.35	12.20
Black Mt. Los Altos	8 p.m.	1952	0.95	2.70	1.65	0.98	6.28
Palo Alto	8 p.m.		0.04	1.84	0.45	0.34	2.67
Searsville Lake	8 a.m.		0.11	2.40	0.85	0.67	4.03
Ben Lomond	5 p.m.	1-3 April	2.25	4.90	1.12		8.27
Skylonda Fire Station	8 a.m.	1958	2.26	3.04	1.49		6.79
Searsville Lake	8 a.m.		1.89	0.57	3.08		5.49
Palo Alto	8 a.m.		0.89	0.21	1.55		2.65
Ben Lomond	5 p.m.	1-3 Jan.	1.00	3.92	1.59		6.51
Palo Alto	5 p.m.	1916	0.20	0.74	3.37		4.31

Note: Maximum hourly rainfall recorded at Palo Alto is 0.76 in./hr. - 10 February 1922.

* Rainfall included in following days total.

TABLE V

ESTIMATED AND RECORDED SEASONAL PEAK DISCHARGES SAN FRANCISQUITO CREEK AT PALO ALTO 1/

Date of occurrence	Estimated annual maximum instantaneous discharge	
	present conditions	project conditions 2/
9 February 1893	800	300
19 February 1894	5,350	1,600
4 January 1895	6,100	1,850
24 April 1896	1,150	200
28 March 1897	2,700	600
24 February 1898	1,950	600
24 March 1899	2,250	650
3 January 1900	2,500	700
5 January 1901	300	200
24 February 1902	850	300
1 April 1903	450	200
17 February 1904	550	250
19 March 1905	550	250
19 January 1906	700	300
2 February	1,350	450
2 February 1908	650	250
21 January 1909	3,800	1,100
24 January 1910	600	250
14 January 1911	5,000	1,500
5 March 1912	700	300
15 January 1913	750	300
20 February 1914	3,000	900
2 February 1915	2,950	850
3 January 1916	4,450	1,350
4 January 1917	1,700	500
11 March 1918	2,700	800
11 February 1919	4,000	1,200
1 March 1920	900	350
17 January 1921	2,200	650
10 February 1922	2,300	650
12 December 1922	1,200	400
26 January 1924	1,000	350
31 March 1925	1,750	550
31 January 1926	1,950	600
3 April 1927	850	300
4 February 1928	2,000	600
1929	0	0
16 January 1930	2,400	700
1931	0	0

TABLE V
(Continued)

ESTIMATED AND RECORDED SEASONAL PEAK DISCHARGES SAN FRANCISQUITO CREEK AT PALO ALTO1/

Date of occurrence	Estimated annual maximum instantaneous discharge	
	present conditions	project conditions 2/
27 December 1931	1,170	400
27 January 1933	651	250
26 February 1934	582	250
8 April 1935	1,540	500
21 February 1936	1,570	500
4 February 1937	2,550	750
11 February 1938	1,400	450
8 February 1939	127	110
27 February 1940	3,100	900
4 April 1941	2,200	650
24 January 1942	2,400	700
21 January 1943	4,400	1,300
4 March 1944	340	200
1 February 1945	2,400	700
27 December 1945	500	250
22 November 1947	260	150
29 April 1948	250	150
10 May 1949	690	300
6 February 1950	1,100	400
19 November 1950	3,600	1,000
14 March 1952	2,300	650
7 December 1952	1,900	550
19 March 1954	320	200
27 February 1955	780	300
22 December 1955	5,560	1,700
18 March 1947	400	200
2 April 1958	4,460	1,300
Mean logarithm of discharge	3,088	
Standard deviation	0.438	
Calculated skew	-0.645	

Note: 1/ Frequency curve as estimated at Palo Alto represents discharges from total effective drainage area of the Basin. Present stream gage is at Stanford University with one square mile elss drainage area. Peak discharges greater than 3,000 c.f.s. required no adjustment.

2/ Values were taken from average reduction curve.

3/ Routing of this flood results in a project condition discharge of 2,000 c.f.s. as shown on Plate A-5.

TABLE VI

UNIT GRAPHS AND BASIC DATA
SAN FRANCISQUITO CREEK

Time (hr)	Los Trancos Creek 1-hr UG	San Francisquito Creek at Stanford 2-hr UG	Reservoir inflow 2-hr UG
0	0	0	0
1	360	260	410
2	1,000	1,100	1,700
3	1,540	2,600	3,200
4	1,200	3,750	3,500
5	520	3,290	2,450
6	370	2,650	1,450
7	290	1,940	980
8	230	1,450	770
9	200	1,100	620
10	160	880	510
11	130	770	410
12	110	590	350
13	90	500	290
14	70	420	240
15	60	360	200
16	50	300	170
17	35	270	140
18	25	230	120
19	20	210	100
20	10	180	90
21	5	160	80
22	5	140	60
23	5	130	50
24	0	110	40
25		100	20
26		100	10
27		100	0
28		90	
29		80	
30		80	
31		70	
32		70	
33		60	
34		60	
35		50	
36		50	
37		40	
38		30	
39		20	
40		10	
41		0	

	Unit	Los Trancos Creek	USGS gage	Reservoir
Drainage area	Sq.mi.	10	37.5	27.5
t_p	hours	2.5	3.0	2.4
W 75	hours	1.8	2.7	2.5
W 50	hours	2.9	4.5	3.7
Average annual precipitation	inches	23.6	32.8	35.7

Notes:

All unit-graph values are instantaneous and in c.f.s.

t_p = Time in hours from center of mass of rainfall excess to peak discharge of unit graph.

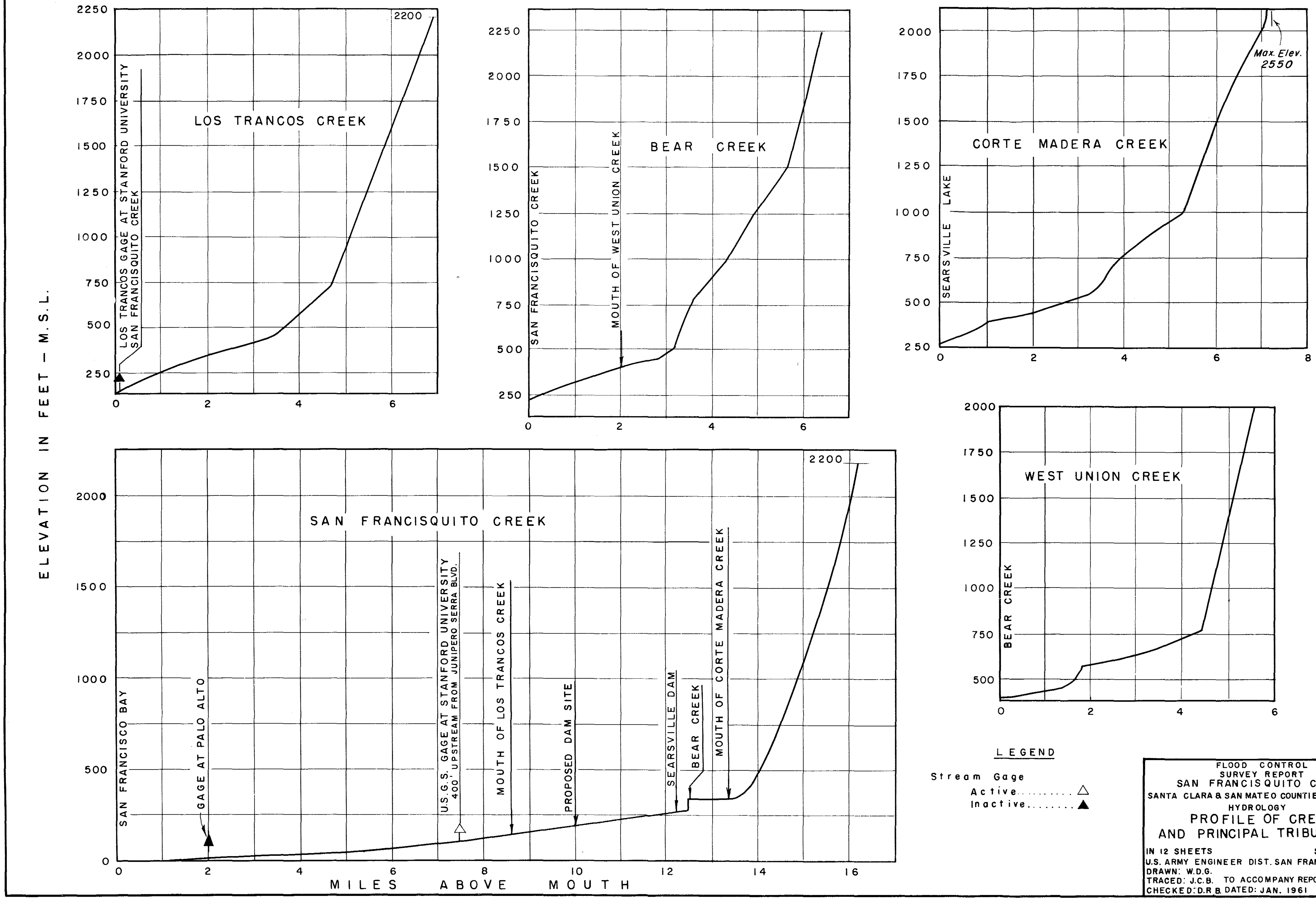
W 75 = Width of unit graph in hours at 75 percent of peak discharge.

W 50 = Width of unit graph in hours at 50 percent of peak discharge.

Los Trancos Creek as used here represents the total local inflow between the proposed damsite and the USGS gage upstream from Junipero Serra Boulevard.

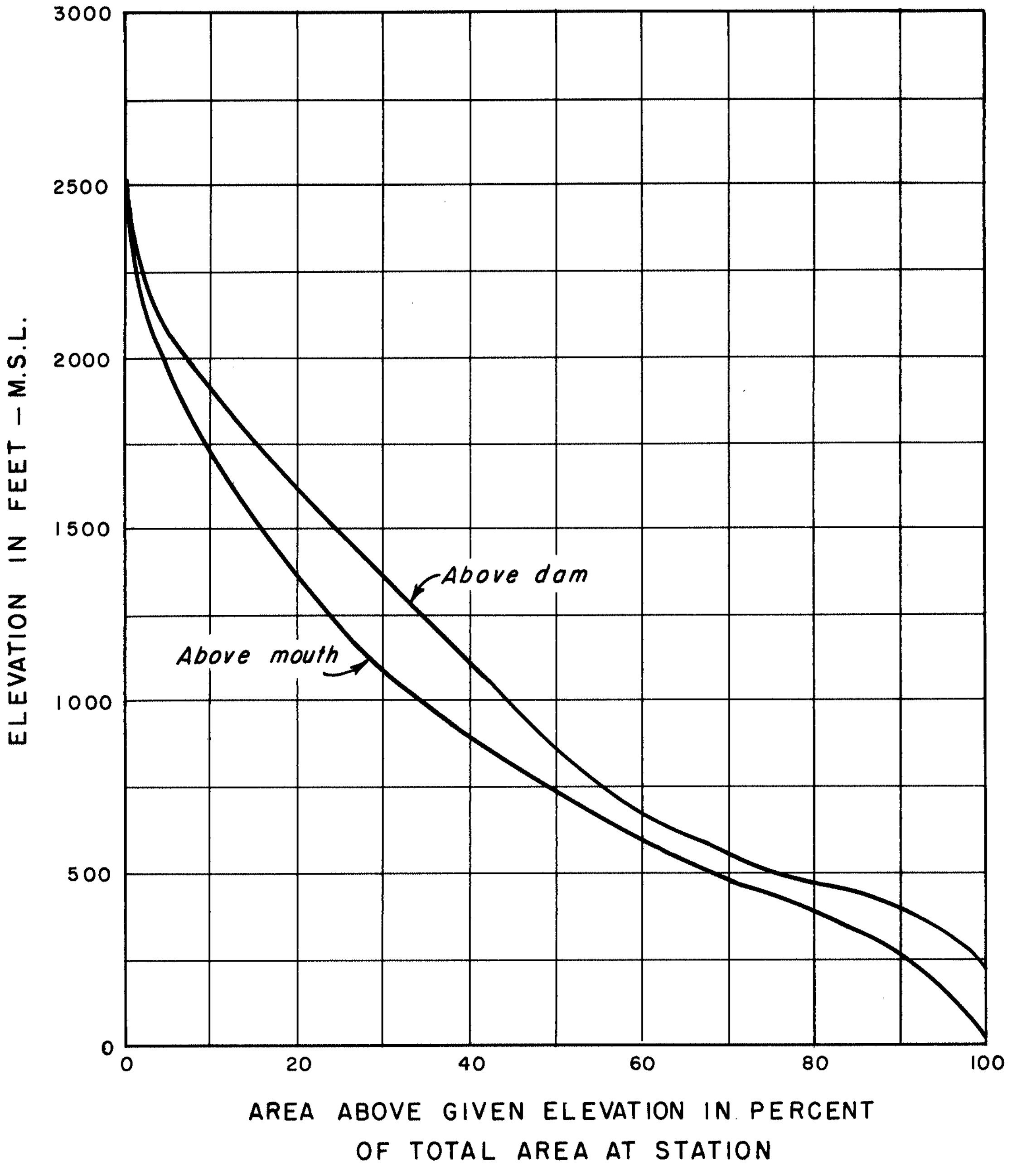
CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY
PROFILE OF CREEK
AND PRINCIPAL TRIBUTARIES
IN 12 SHEETS SHEET NO. 1
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C.OF E.
DRAWN: W.D.G.
TRACED: J.C.B. TO ACCOMPANY REPORT FILE NO.
CHECKED: D.R.B. DATED: JAN. 1961 72-46-1

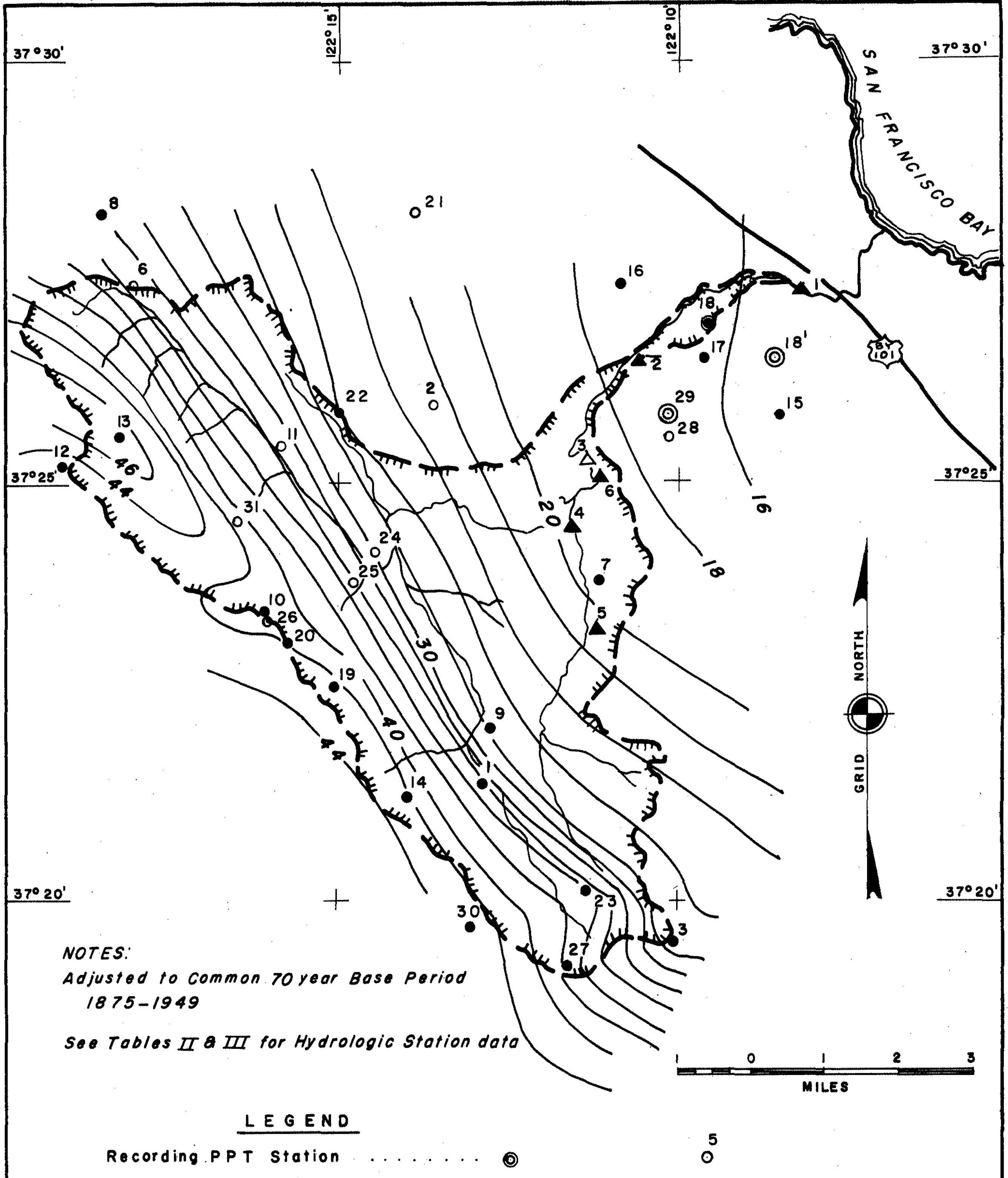
PLATE A-1



FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

BASIN AREA–ELEVATION CURVES

IN 12 SHEETS SHEET NO. 2
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W.D.G.
TRACED: J.C.B.
CHECKED: D.R.B.
TO ACCOMPANY REPORT
DATED: JAN. 1961
FILE NO.
72-46-1



NOTES:

Adjusted to Common 70 year Base Period 1875-1949

See Tables II & III for Hydrologic Station data

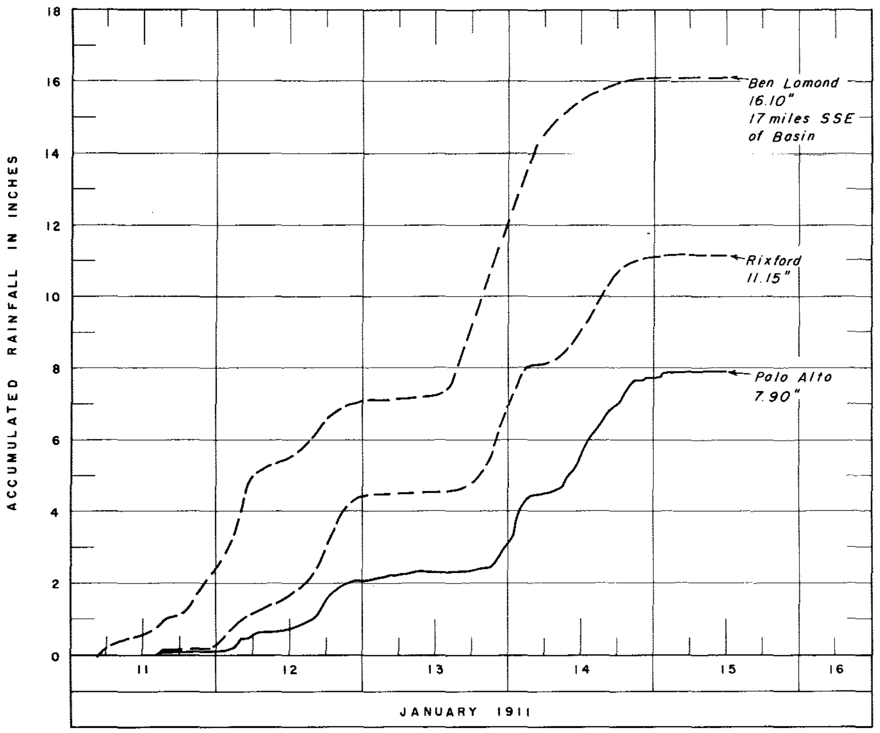
LEGEND

Recording PPT Station	◎
Non-Recording PPT Station	
Active	○
Inactive	●
Isohyets	—20—
Stream Gage	
Active	△
Inactive	▲

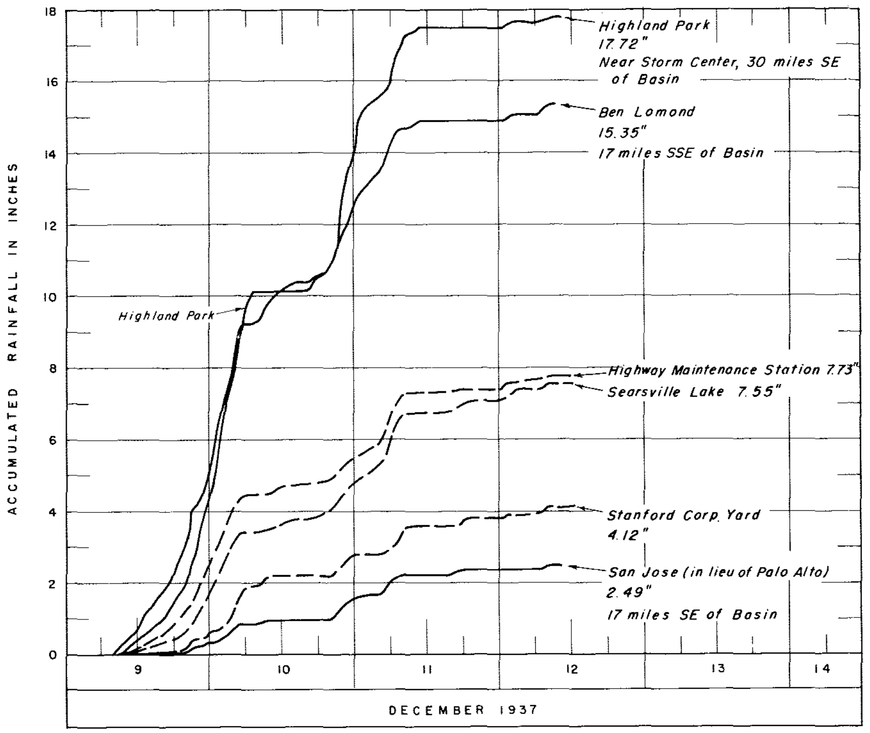
FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

AVERAGE ANNUAL ISOHYETS
INDEX MAP OF HYDROLOGIC STATIONS

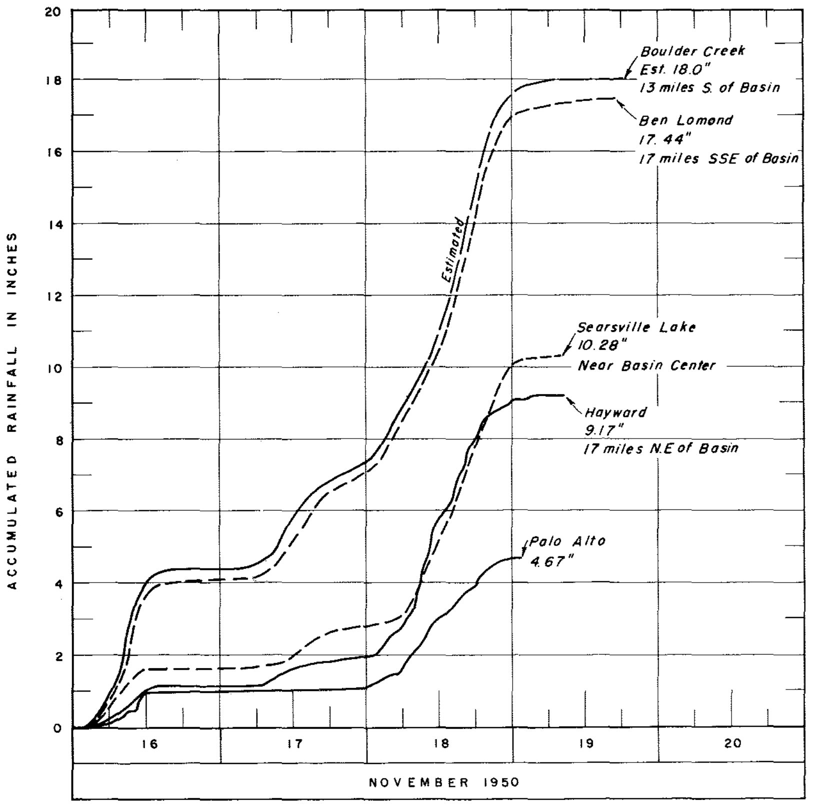
IN 12 SHEETS SHEET NO. 3
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W.D.G.
TRACED: J.C.B. TO ACCOMPANY REPORT
CHECKED: D.R.B. DATED: JAN. 1961
FILE NO. 72-46-1



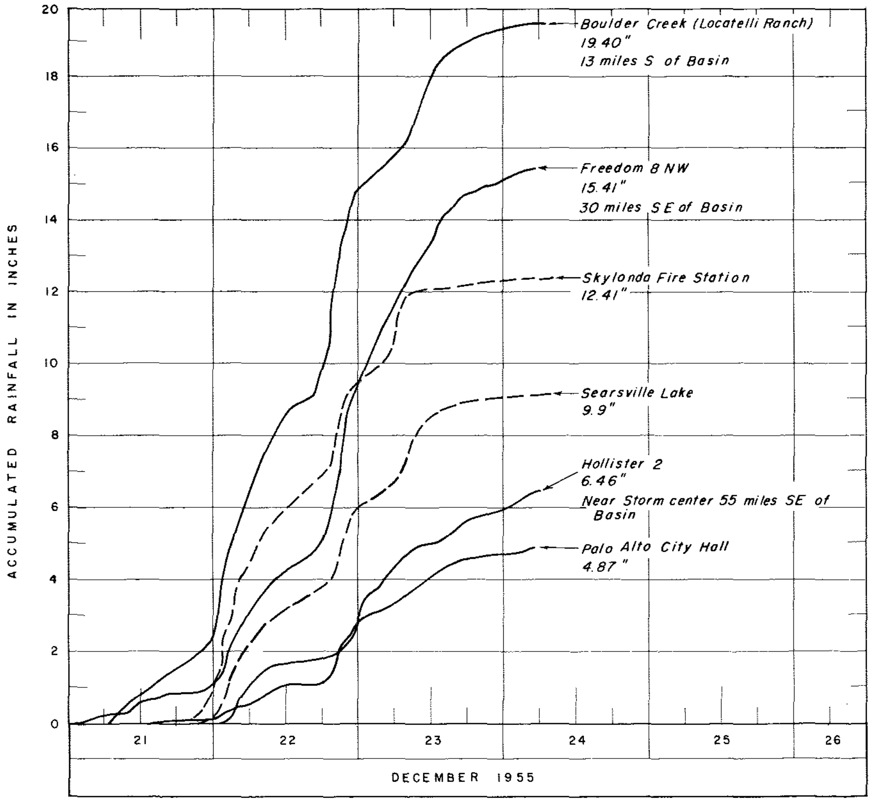
STORM OF 11-14 JANUARY 1911



STORM OF 9-12 DECEMBER 1937



STORM OF 16-18 NOVEMBER 1950



STORM OF 21-24 DECEMBER 1955

LEGEND

Recorder .... ———

Curve Using Daily Totals .... — — —

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

MASS RAINFALL CURVES

MAJOR STORMS OF RECORD

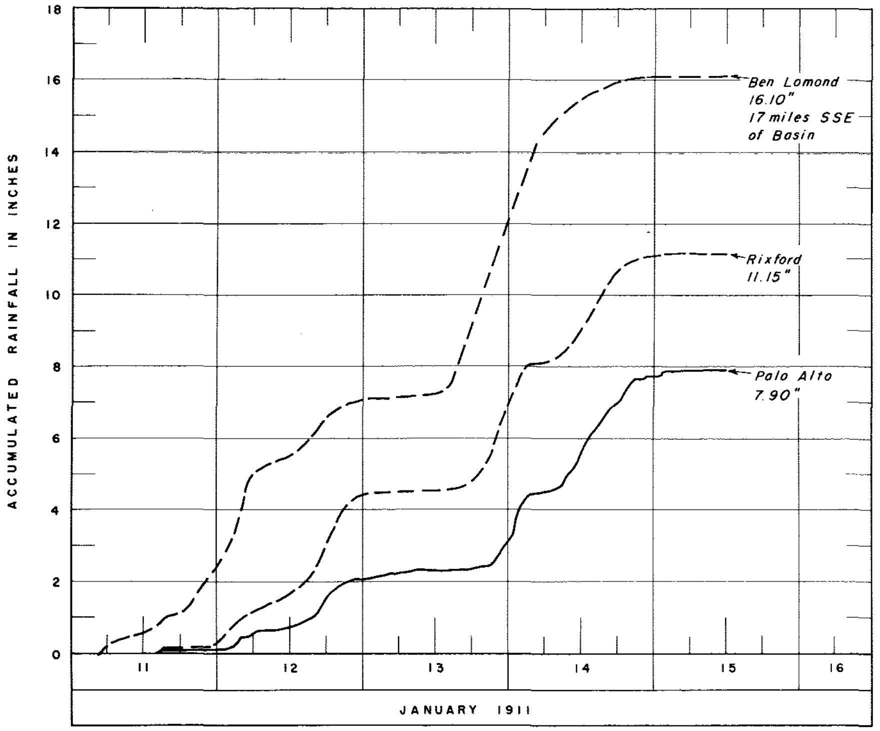
IN 12 SHEETS SHEET NO. 4

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS, 10 JUN'5

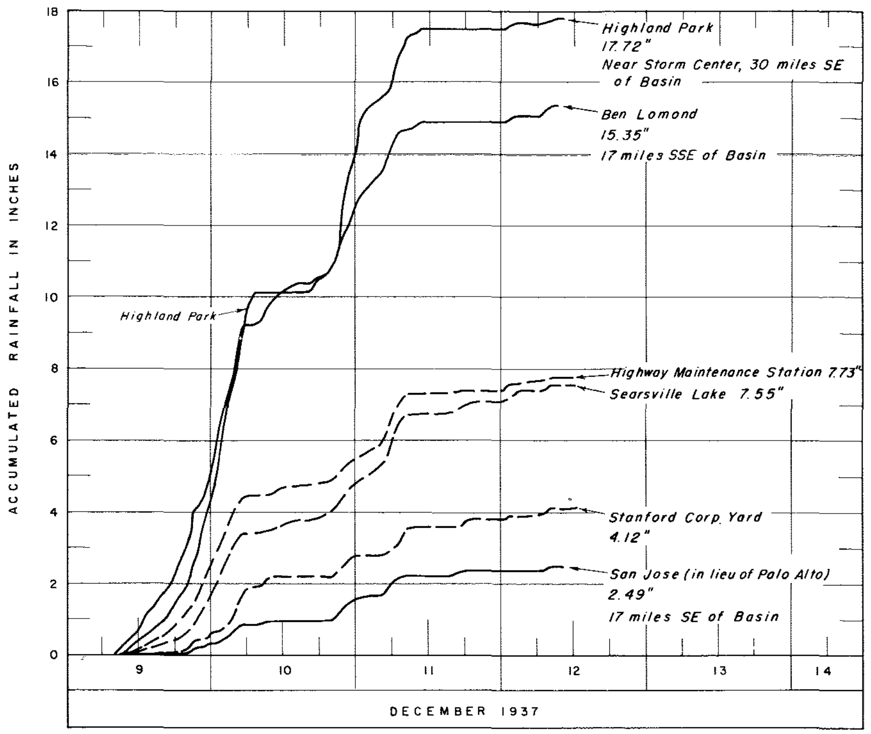
DRAWN: W.D.G.
TRACED: J.C.B.
CHECKED D.R.B.

TO ACCOMPANY REPORT
DATED: JANUARY 1961

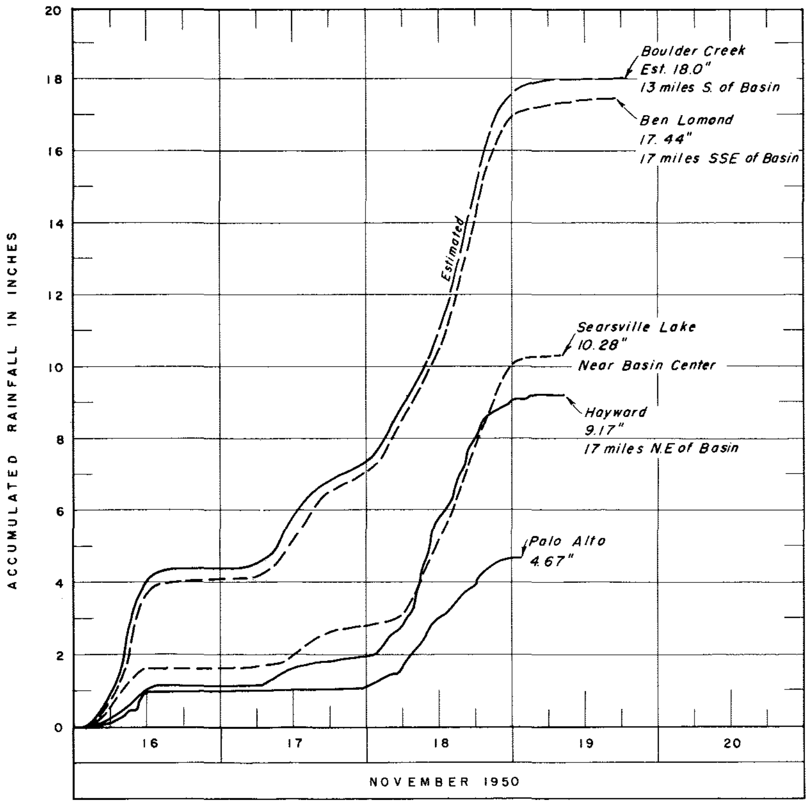
FILE NO.
72-46-1



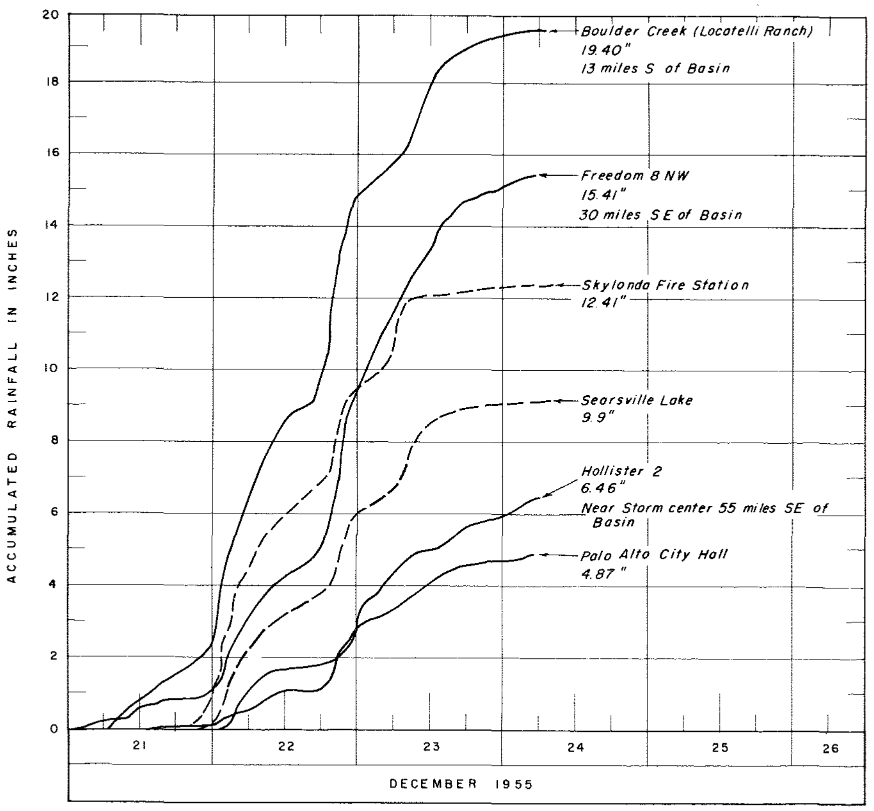
STORM OF 11-14 JANUARY 1911



STORM OF 9-12 DECEMBER 1937



STORM OF 16-18 NOVEMBER 1950



STORM OF 21-24 DECEMBER 1955

LEGEND

Recorder ———
Curve Using Daily Totals — — —

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

MASS RAINFALL CURVES
MAJOR STORMS OF RECORD

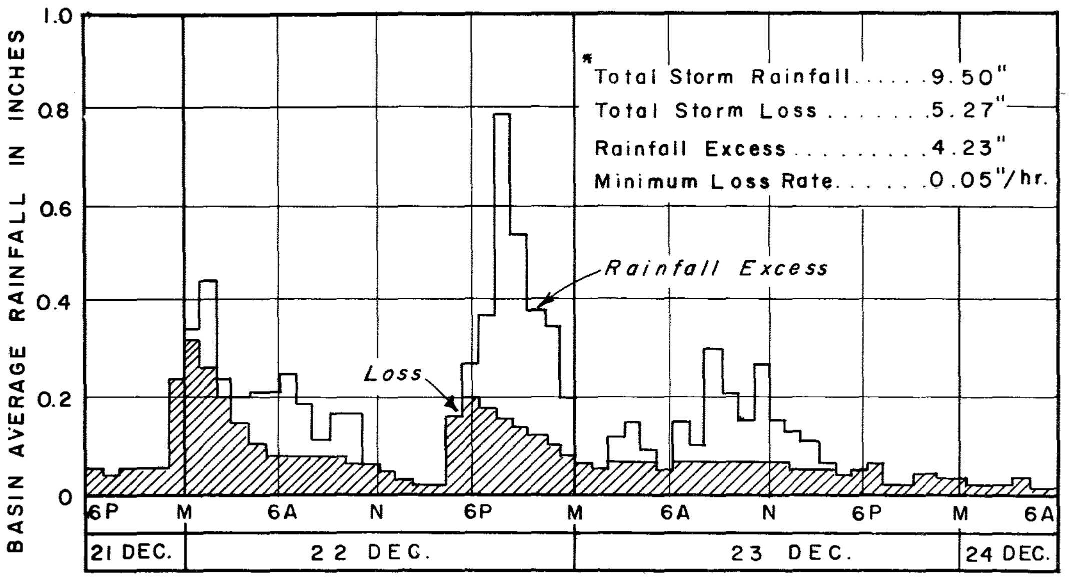
IN 12 SHEETS SHEET NO. 4

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS, 10 JUN 58

DRAWN: W.D.G.
TRACED: J.C.B.
CHECKED: D.R.B.

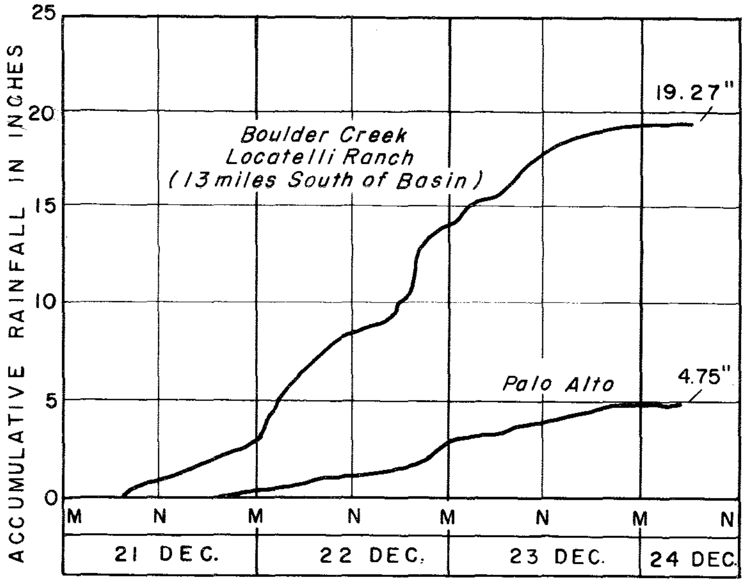
TO ACCOMPANY REPORT
DATED: JANUARY 1961

FILE NO.
72-46-1

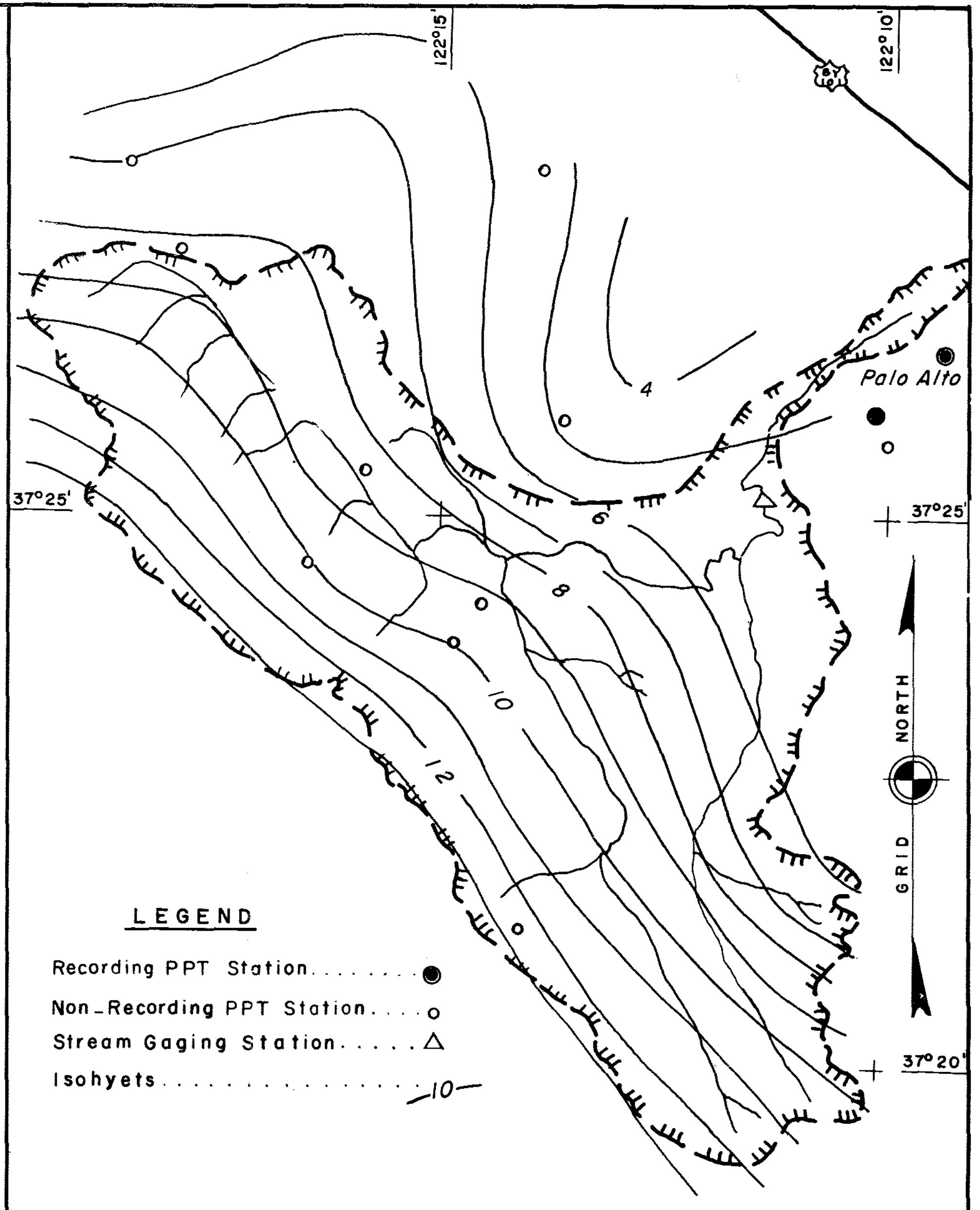


*Total Storm Rainfall......9.50"
Total Storm Loss.......5.27"
Rainfall Excess.........4.23"
Minimum Loss Rate......0.05"/hr.

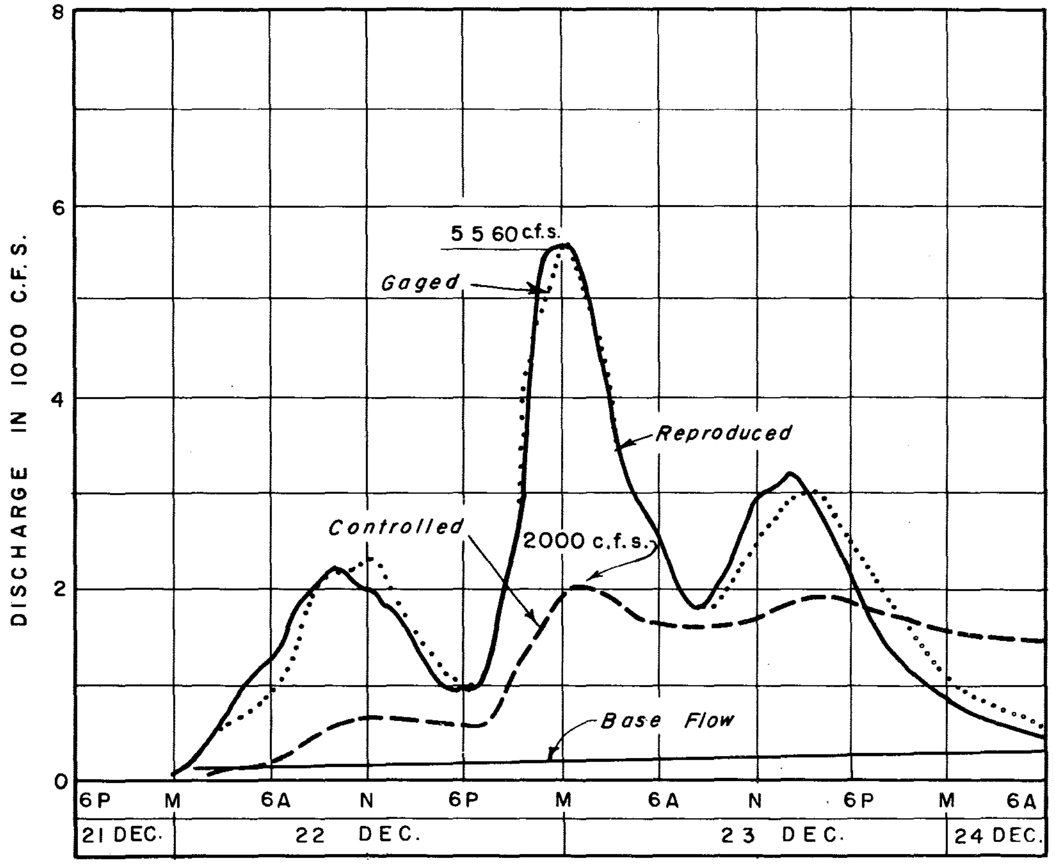
*Distribution based on Palo Alto and Boulder Creek



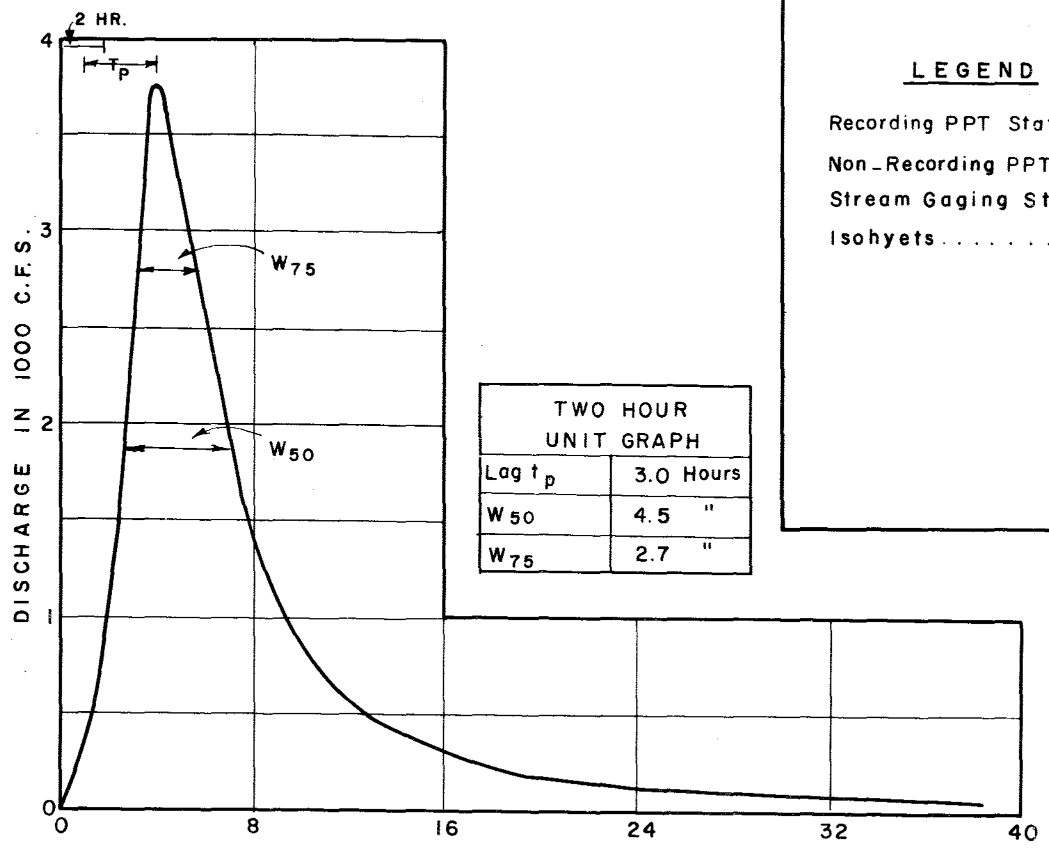
MASS RAINFALL CURVES
PALO ALTO AND BOULDER CREEK


122°15'
122°10'
Palo Alto
4
6
8
10
12
37°25'
37°25'
37°20'
GRID NORTH
LEGEND
Recording PPT Station........ ●
Non-Recording PPT Station.... ○
Stream Gaging Station..... △
Isohyets.................. 10

ISOHYETAL MAP
21-24 DECEMBER 1955



HYDROGRAPHS



TWO HOUR UNIT GRAPH	
Lag t_p	3.0 Hours
W_{50}	4.5 "
W_{75}	2.7 "

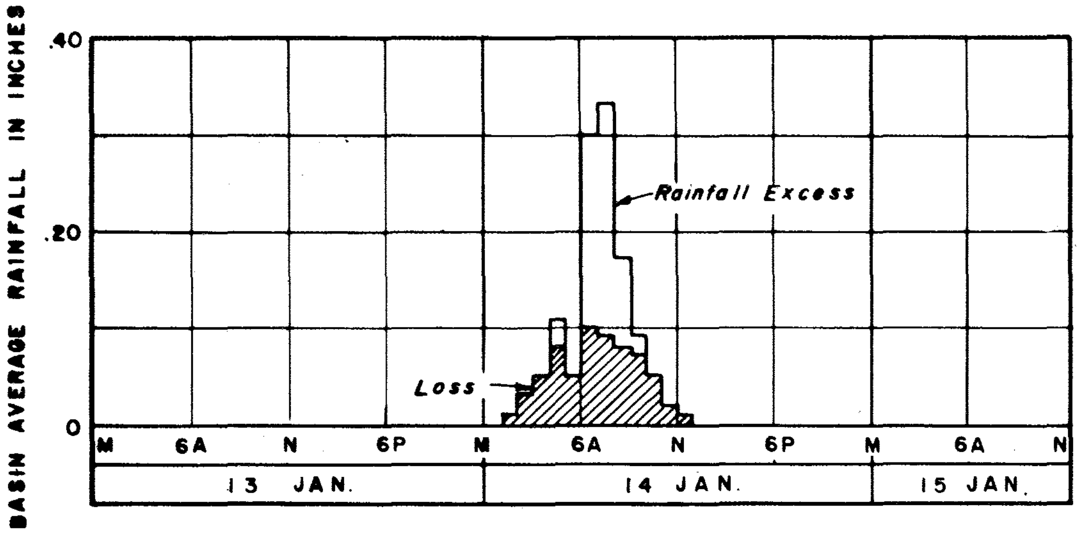
TWO HOUR UNIT HYDROGRAPH

SAN FRANCISQUITO CREEK AT U.S.G.S. GAGE, STANFORD UNIVERSITY

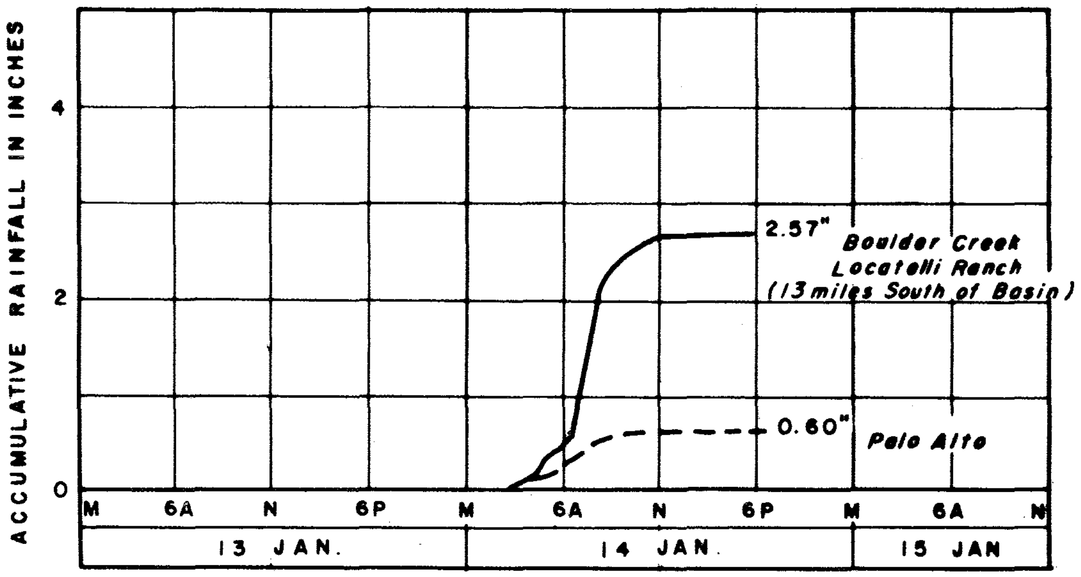
FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

HYDROLOGIC DATA

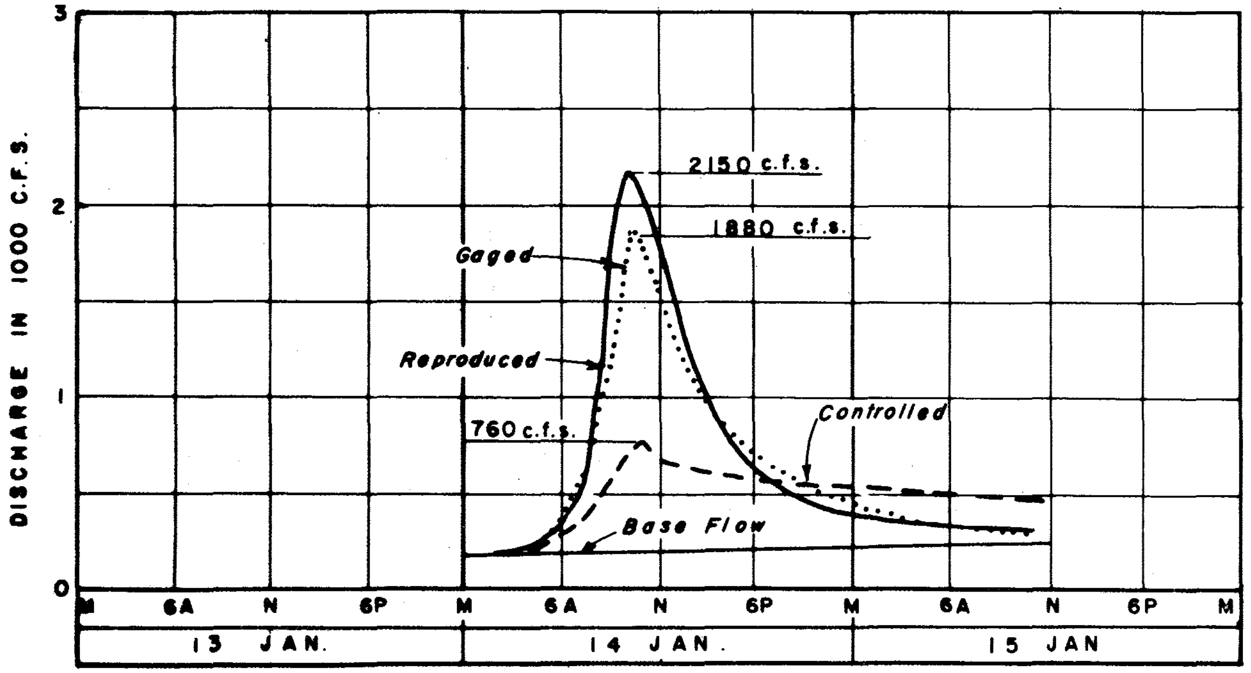
STORM OF 21-24 DECEMBER 1955
IN 12 SHEETS SHEET NO. 5
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W.D.G.
TRACED: J.C.B. TO ACCOMPANY REPORT FILE NO.
CHECKED: D.R.B. DATED: JAN. 1961 72-46-1



Total Storm Rainfall	1.20"
Total Storm Loss	0.62"
Rainfall Excess	0.58"
Drainage Area	37.5 sq. mi.



MASS RAINFALL CURVES
PALO ALTO AND BOULDER CREEK



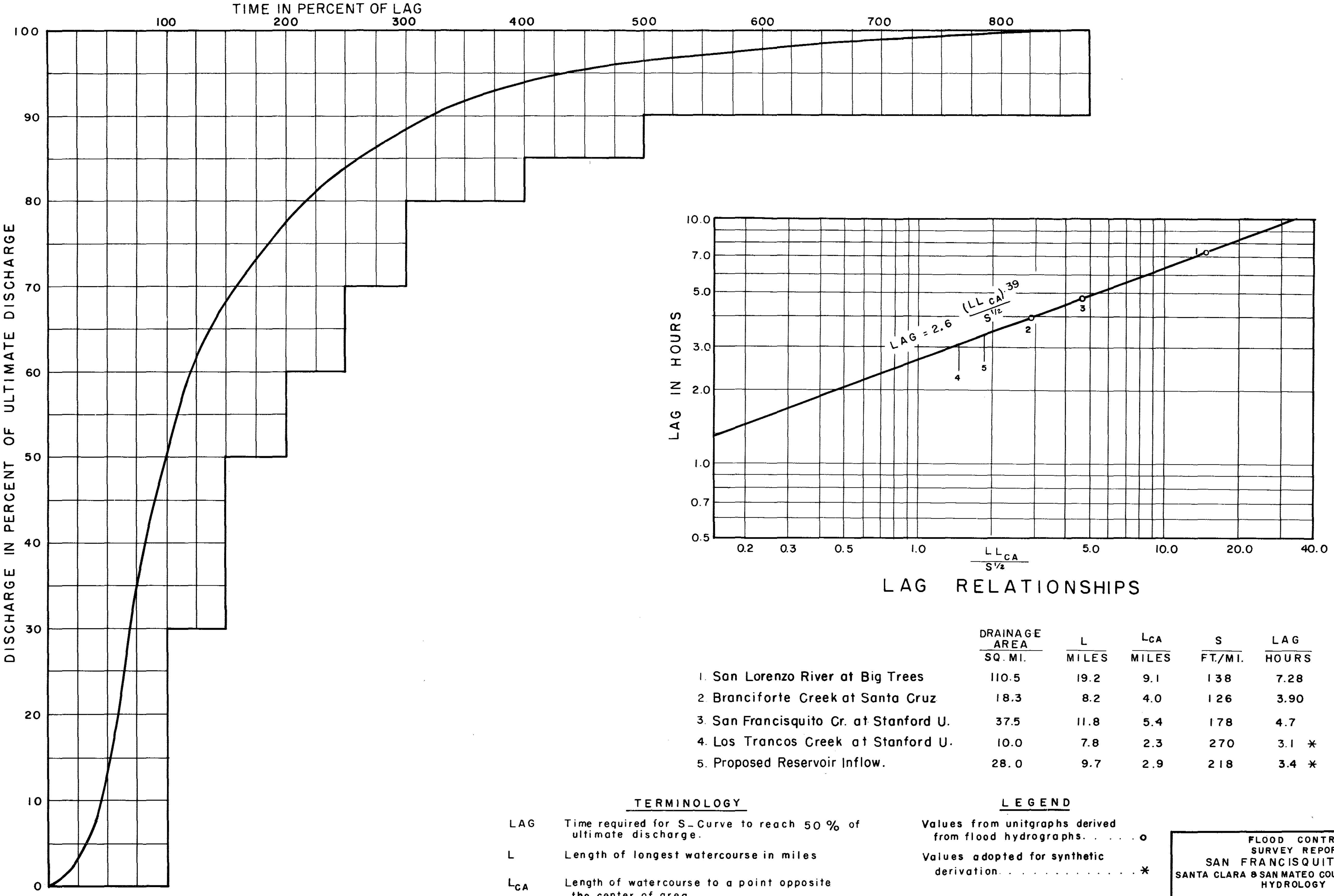
DISCHARGE HYDROGRAPHS
SAN FRANCISQUITO CREEK
AT U.S.G.S. GAGE, STANFORD UNIVERSITY

NOTE:
Precipitation data insufficient to construct isohyetal map. The average basin precipitation was determined by Palo Alto multiplied by the factor 2.02. Factor determined from average of four storms and mean seasonal.

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

HYDROLOGIC DATA
STORM OF 14 JANUARY 1952

IN 12 SHEETS SHEET NO. 6
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W.D.G. FILE NO.
TRACED: J.C.B. TO ACCOMPANY REPORT
CHECKED: D.R.B. DATED: JAN. 1961 72-46-1



AVERAGE S-CURVE HYDROGRAPH

LAG RELATIONSHIPS

	DRAINAGE AREA SQ. MI.	L MILES	L_{CA} MILES	S FT./MI.	LAG HOURS
1. San Lorenzo River at Big Trees	110.5	19.2	9.1	138	7.28
2. Branciforte Creek at Santa Cruz	18.3	8.2	4.0	126	3.90
3. San Francisquito Cr. at Stanford U.	37.5	11.8	5.4	178	4.7
4. Los Trancos Creek at Stanford U.	10.0	7.8	2.3	270	3.1 *
5. Proposed Reservoir Inflow.	28.0	9.7	2.9	218	3.4 *

TERMINOLOGY

LAG	Time required for S-Curve to reach 50 % of ultimate discharge.
L	Length of longest watercourse in miles
L_{CA}	Length of watercourse to a point opposite the center of area
S	Over-all slope of drainage area between headwaters and collection point in feet per mile

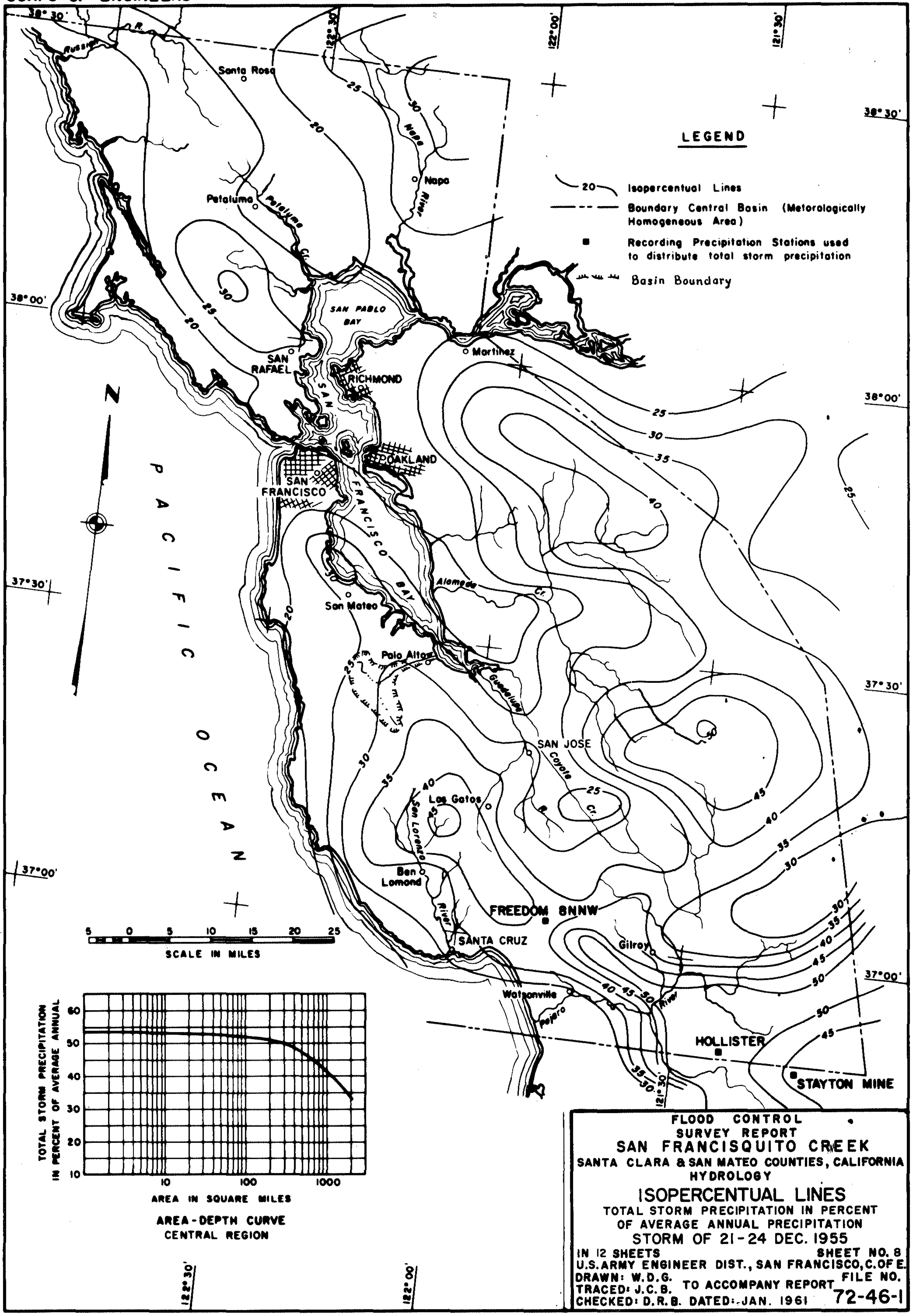
LEGEND

Values from unitgraphs derived from flood hydrographs.	o
Values adopted for synthetic derivation.	*

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

UNIT HYDROGRAPH
CHARACTERISTICS

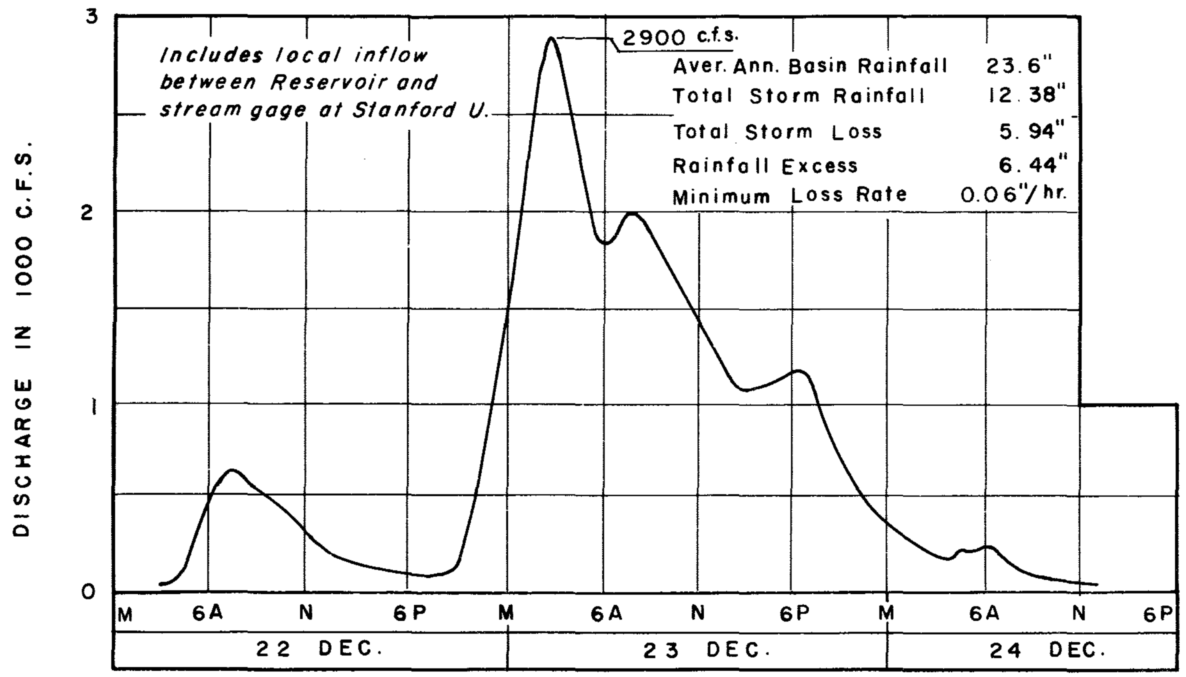
IN 12 SHEETS SHEET NO. 7
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C.OF E.
DRAWN: W.D.G. FILE NO
TRACED: J.C.B. TO ACCOMPANY REPORT
CHECKED: D.R.B. DATED: JAN. 1961 72-46-1



AREA-DEPTH CURVE
CENTRAL REGION

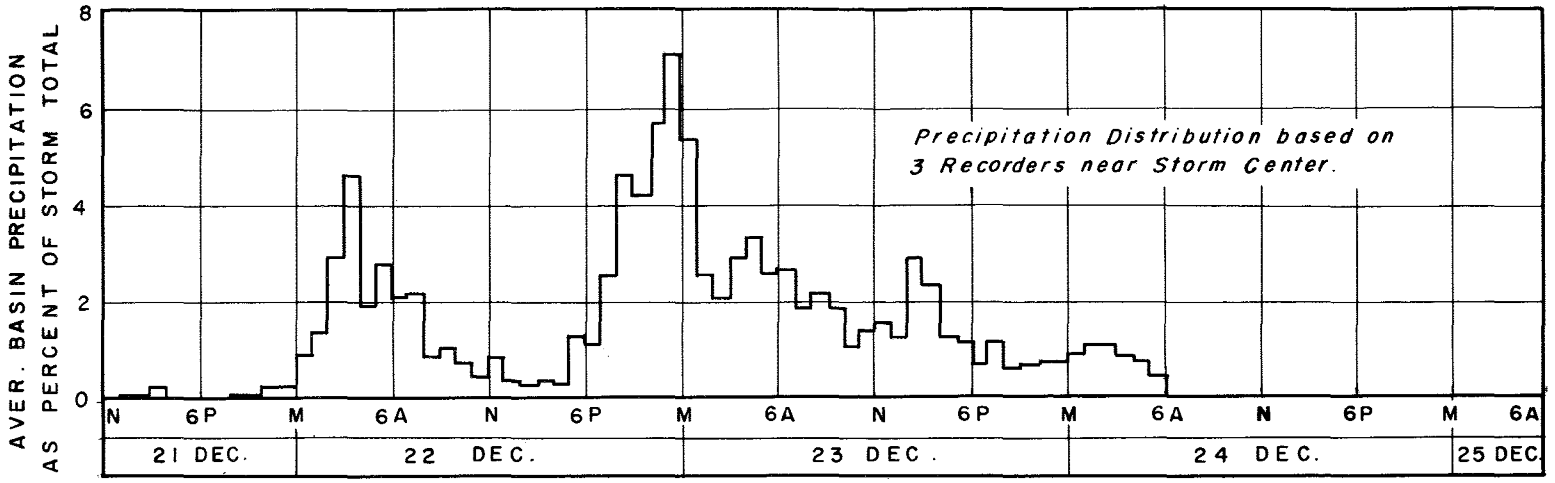
FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

ISOPERCENTUAL LINES
TOTAL STORM PRECIPITATION IN PERCENT
OF AVERAGE ANNUAL PRECIPITATION
STORM OF 21-24 DEC. 1955
IN 12 SHEETS SHEET NO. 8
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E.
DRAWN: W.D.G.
TRACED: J.C.B. TO ACCOMPANY REPORT FILE NO.
CHECKED: D.R.B. DATED: JAN. 1961 72-46-1

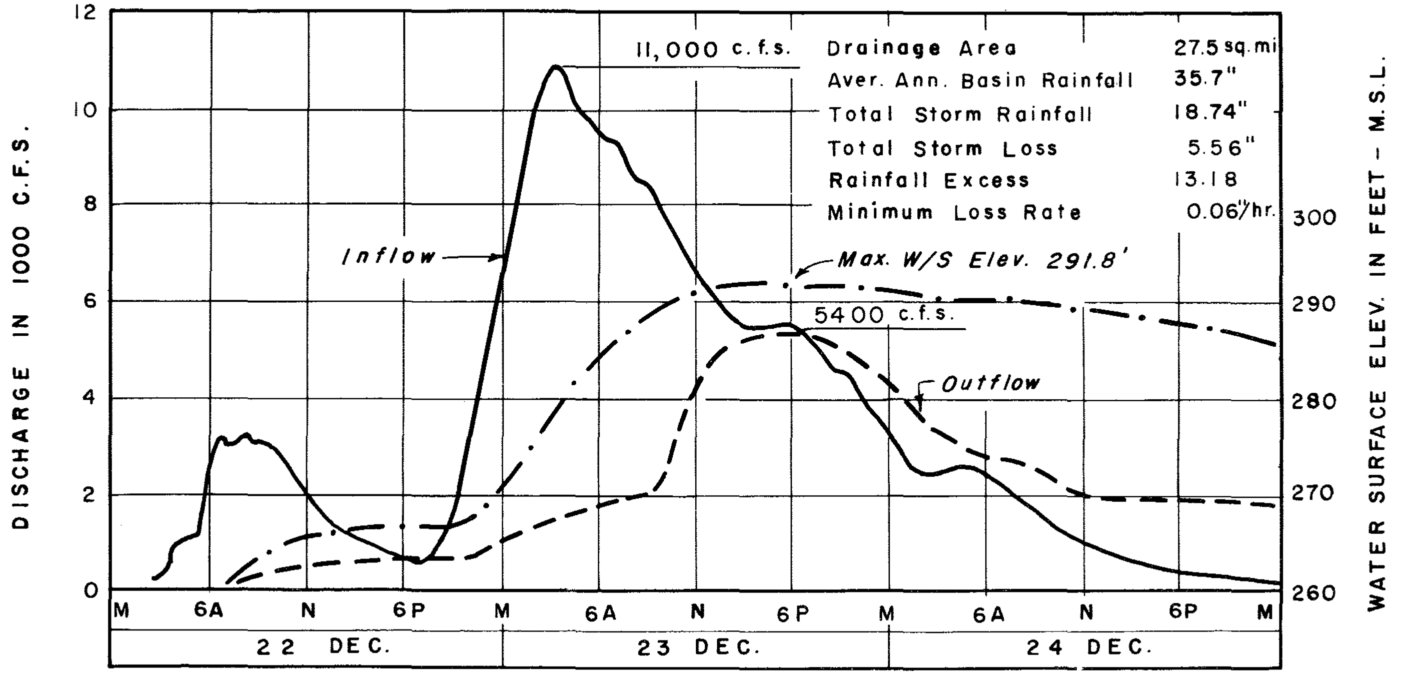


S.P.F. DISCHARGE HYDROGRAPH
LOS TRANCOS CREEK AT MOUTH

22-24 DECEMBER 1955
(Storm Transposition)

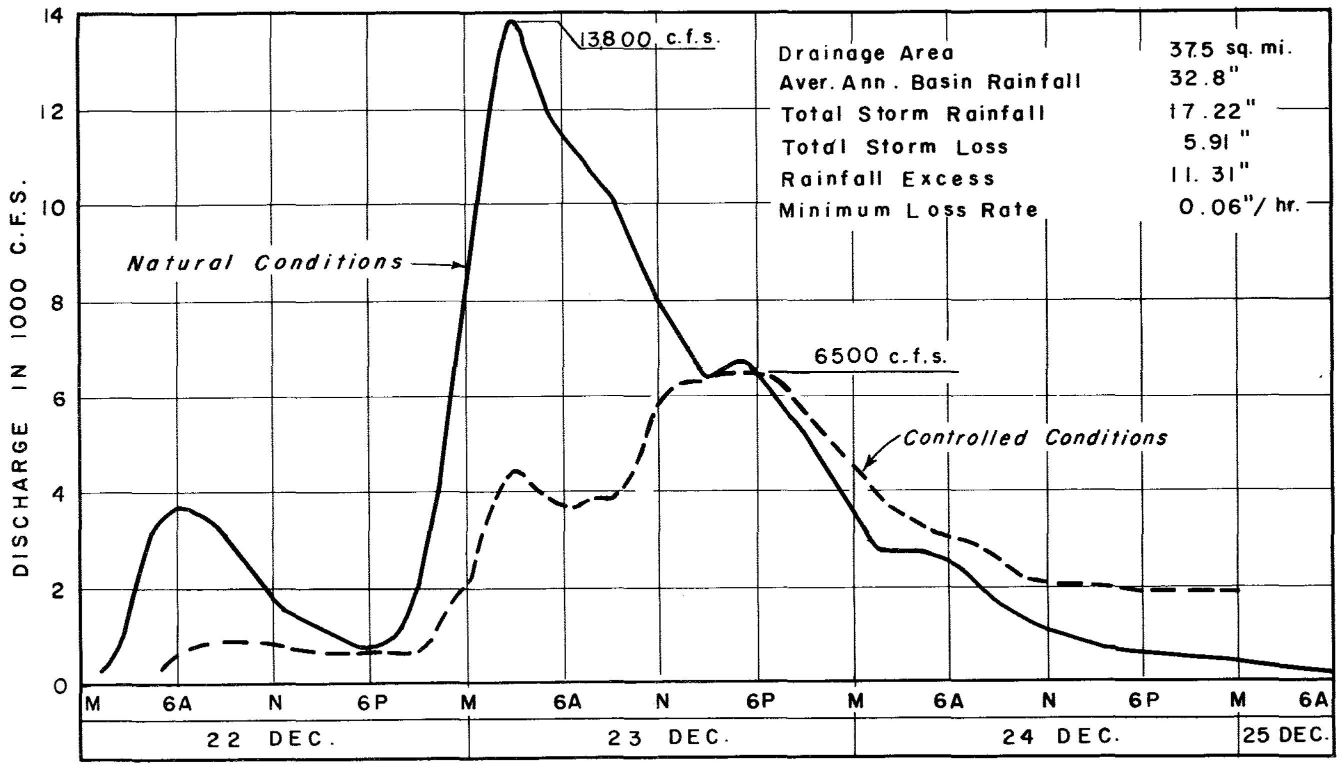


STORM OF 21-24 DECEMBER 1955
TRANSPOSED OVER
SAN FRANCISQUITO CREEK BASIN



S.P.F. RESERVOIR INFLOW & OUTFLOW

22-24 DECEMBER 1955
(Storm Transposition)

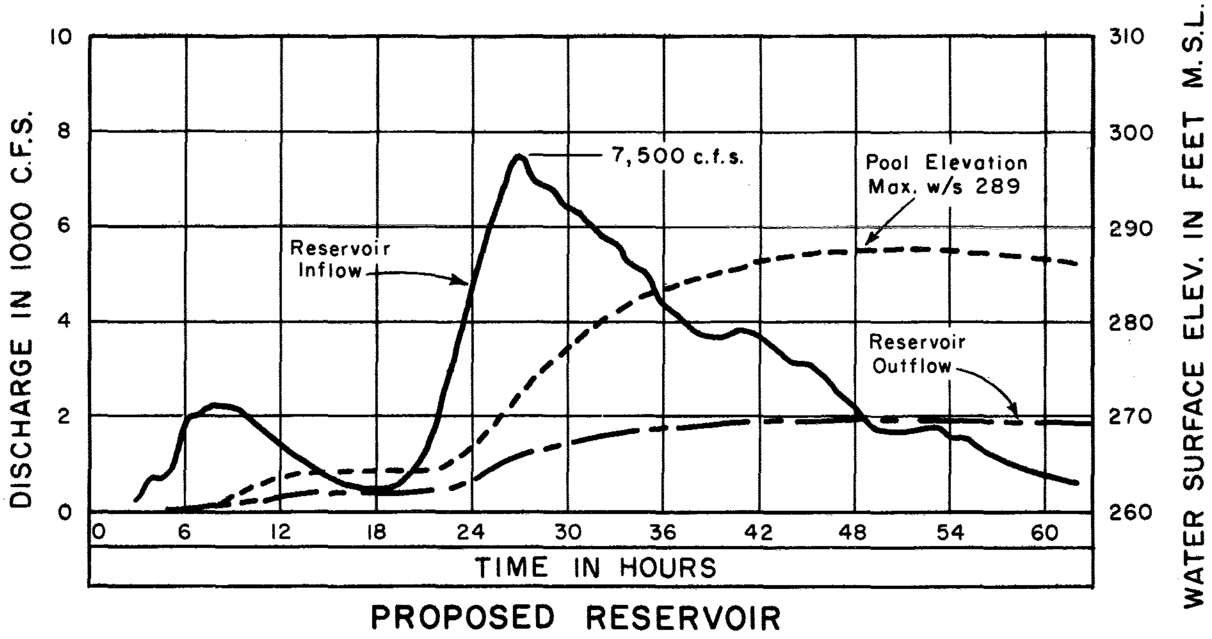


S.P.F. DISCHARGE HYDROGRAPH
SAN FRANCISQUITO CREEK
AT U.S.G.S. GAGE, STANFORD UNIVERSITY

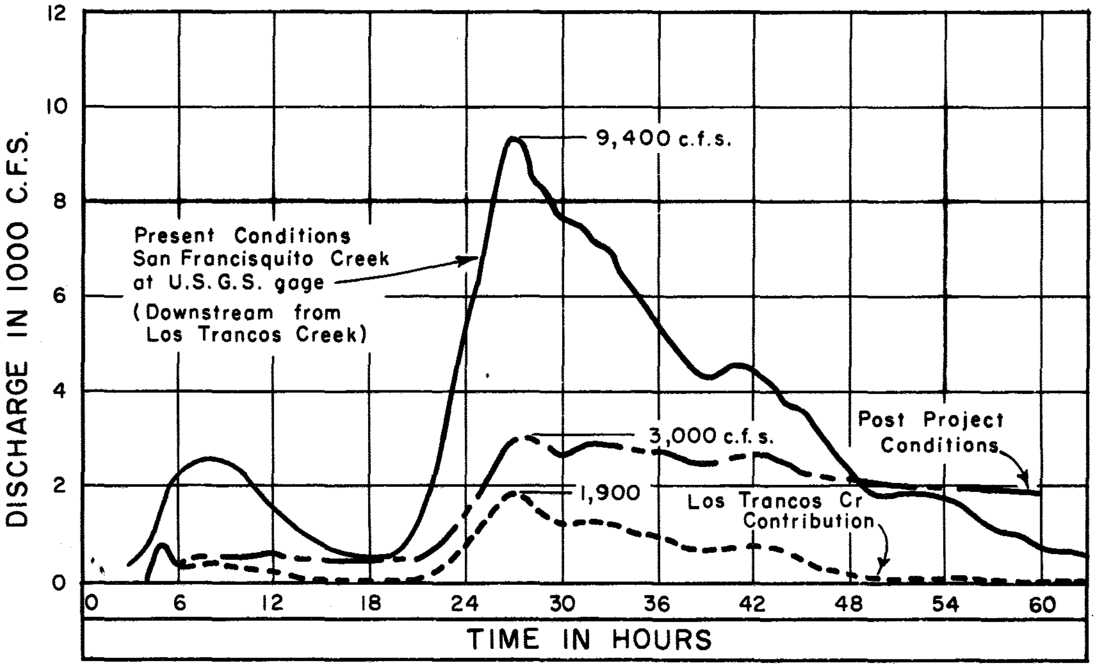
FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

HYDROGRAPHS
STANDARD PROJECT FLOOD

IN 12 SHEETS SHEET NO. 9
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W.D.G. FILE NO.
TRACED. J.C.B. TO ACCOMPANY REPORT
CHECKED: D.R.B. DATED: JAN. 1961 72-46.1



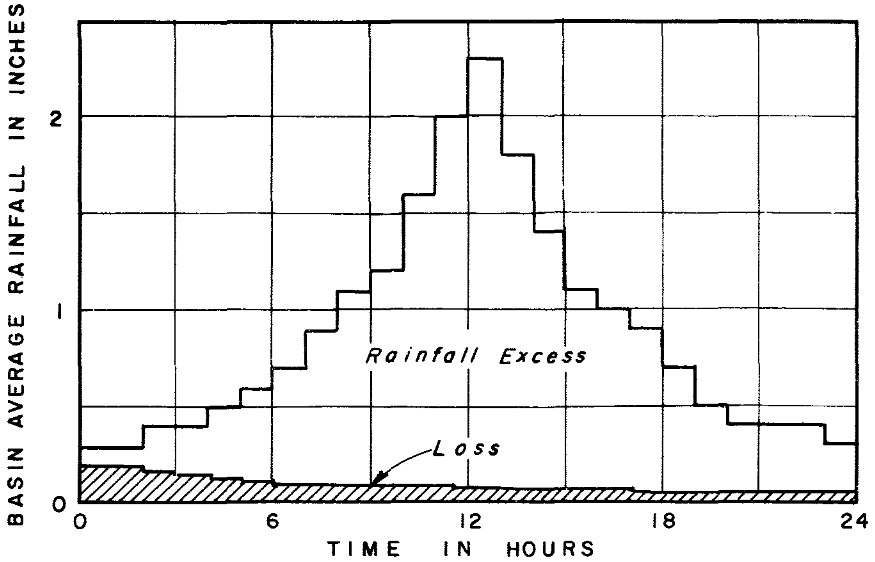
PROPOSED RESERVOIR



SAN FRANCISQUITO CR. & LOS TRANCOS CR.

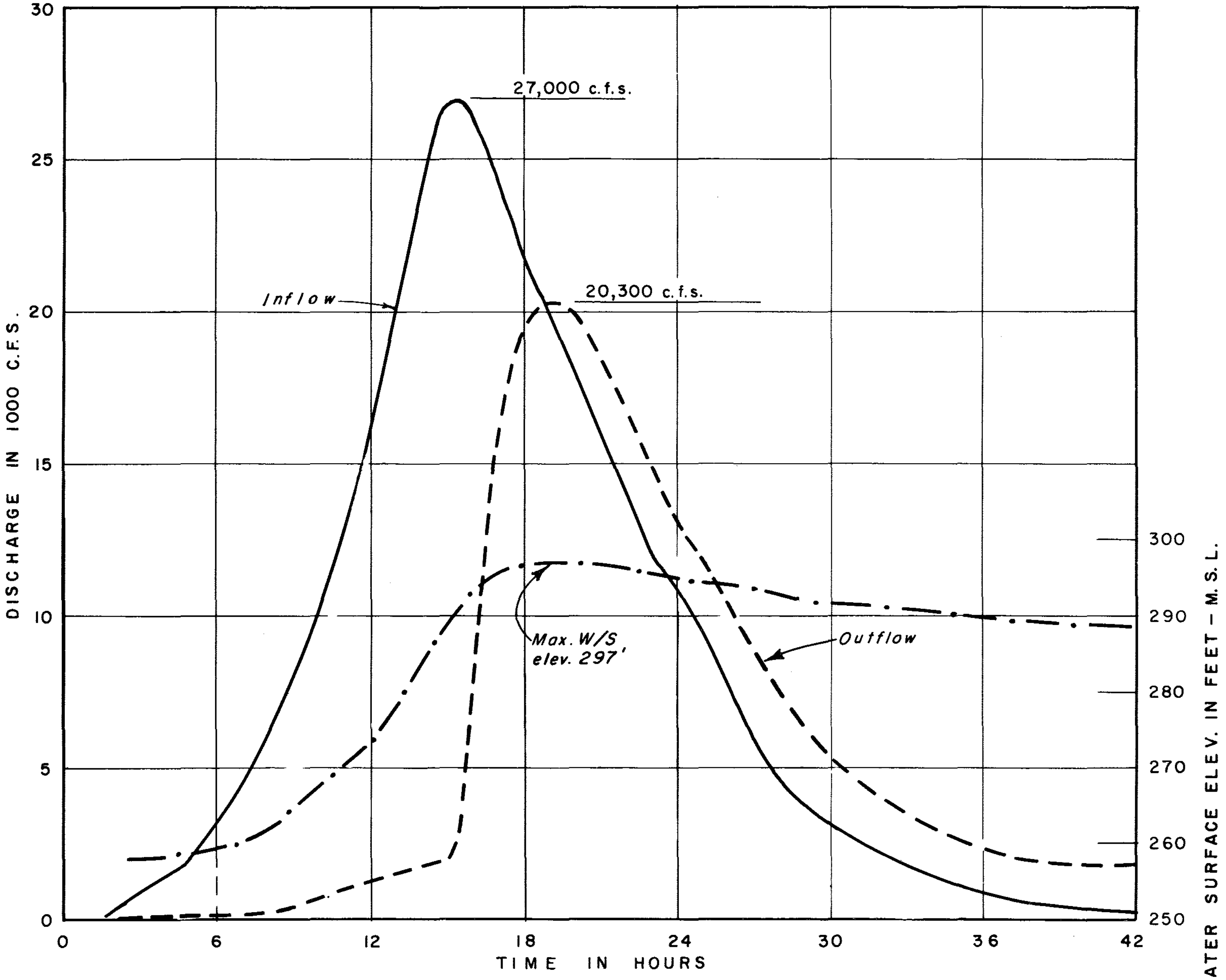
NOTE:
BASED ON 68 PERCENT OF
STANDARD PROJECT FLOOD.

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY
HYDROGRAPHS
RESERVOIR DESIGN FLOOD
IN 12 SHEETS SHEET NO. 10
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W. D. G. FILE NO.
TRACED: I. M. H. TO ACCOMPANY REPORT 72-46-1
CHECKED: D. R. B. DATED: JAN. 1961

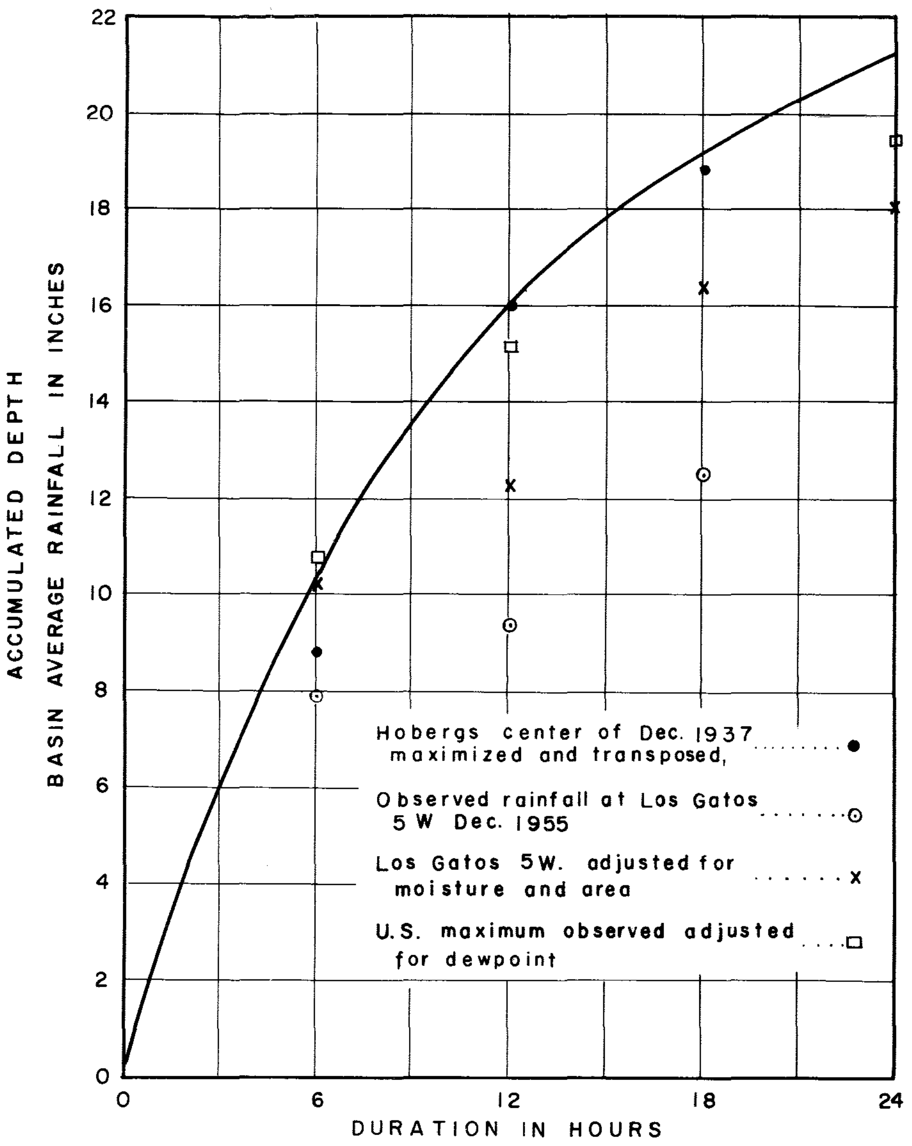


Drainage Area	28 sq. mi.
Total Storm Rainfall	21.20"
Total Storm Loss	2.36"
Minimum Loss Rate	0.06"/hr.
Rainfall Excess	18.84"
Total Runoff	19.30"

Precipitation distribution as recommended by the Hydrometeorological Section of the U.S. Weather Bureau in memorandum dated 28 March, 1957.



P.M.F. RESERVOIR INFLOW & OUTFLOW



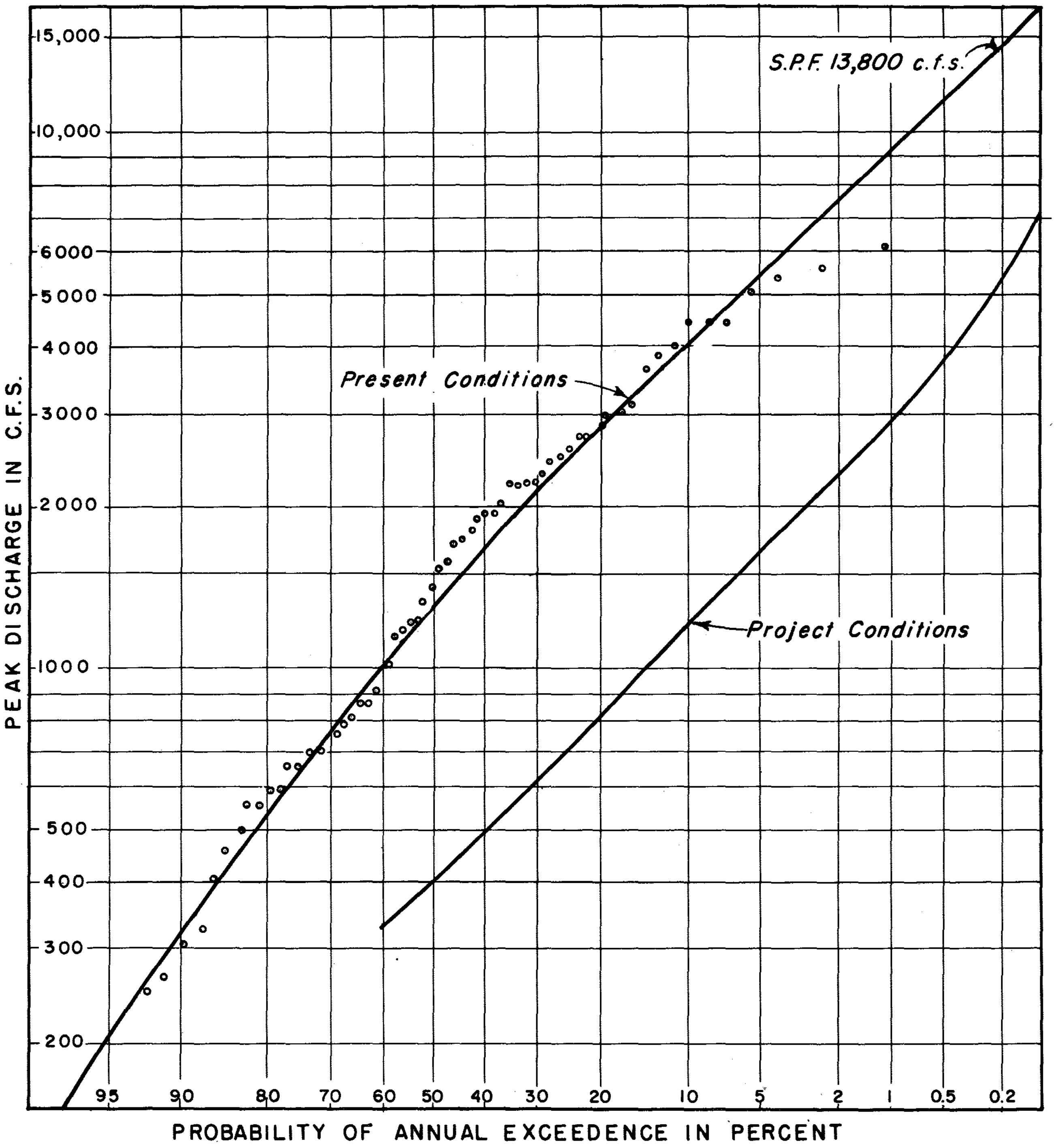
PROBABLE MAXIMUM PRECIPITATION

U.S. WEATHER BUREAU REVISED ESTIMATE - 30 JAN. 1958

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

PROBABLE MAXIMUM STORM AND SPILLWAY DESIGN FLOOD

IN 12 SHEETS SHEET NO. 11
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: W.D.G.
TRACED: J.C.B. TO ACCOMPANY REPORT FILE NO.
CHECKED: D.R.B. DATED: JAN. 1961 72-46-1



NOTES:

1893-1911 Based on Searsville Lake data

1912-1930 " " Rainfall study

1931-1941 " " Gage Readings

1942-1950 " " Correlation with San Lorenzo River at Big Trees

1951-1958 " " Gage at Stanford University

** Present gage is at Stanford University*
Discharge in excess of 3,000 c.f.s. require no adjustment.

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
HYDROLOGY

DISCHARGE FREQUENCY CURVE
AT PALO ALTO *

IN 12 SHEETS SHEET NO.12
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C.OF E.
DRAWN: W.D.G.
TRACED: J.C.B. TO ACCOMPANY REPORT
CHECKED: D.R.B. DATED: JAN. 1961
FILE NO. 72-46-1

REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX B

GEOLOGY, SOILS AND CONSTRUCTION MATERIALS

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Plates

B-1	LOCATION MAP - BORROW AREA
B-2	PLANS AND SECTIONS

REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX B

GEOLOGY, SOILS AND CONSTRUCTION MATERIALS

SCOPE

B-1. GENERAL

The San Francisquito damsite is across San Francisquito Creek on Stanford University land about 4,000 feet west of Alpine Road. In 1934, Stanford University studied a San Francisquito site at the Little Francis axis about 2,000 feet upstream (west) of the proposed axis. These studies which supply the only geologic and soils data for the area included a geologic report by Tolman[1a] and a soils report by Rawhauser and Poland[1b]. Small-scale geologic maps of the region have been prepared by the California Division of Mines[2] and the U.S. Geological Survey[3]. Areal reconnaissance of the proposed axis was done in the spring of 1958 by geologists and soils engineers of the Foundations and Materials Branch. Right-of-entry for subsurface exploration work was not obtainable without incurring unfavorable reaction of the owner of the reservoir site and probable delay in completion of the design of the dam for this report. An inspection of the damsite and reservoir area and review of exploration accomplished by others at a damsite upstream from the proposed dam showed no conditions that could not be provided for by normal design and construction methods. A conservative design has therefore been adopted rather than resorting to unusual measures necessary to obtain the right-of-entry for accomplishing the subsurface explorations.

GEOLOGY

B-2. TOPOGRAPHY

San Francisquito Creek heads in Searsville Lake and flows easterly and southeasterly for two miles through the reservoir on a gradient of 50 feet per mile. Hills north of the reservoir are gently rolling range land. South of the reservoir a prominent ridge rises 400 feet with a slope of 1-1/4 horizontally to 1 vertically and is covered with a dense growth of trees and brush. The valley floor is flat, about 1,000 feet wide with the creek entrenched in a 20-foot deep channel. Trees and brush line the water course.

B-3. AREAL GEOLOGY

Bedrock at the damsite is sandstone and shale. Eocene sandstone and shale underlies the right abutment and most of the reservoir area. It is dense, massive, moderately well indurated, fine-grained sandstone alternating with fine-grained, compact, sandy shale and nodular black shale that dips steeply to the south (Tolman) [1a]. Miocene sandstone and shale underlies the valley floor and the left abutment. It is comparatively compact but soft and easily erodable, fine-grained sandstone and some clay shale that dips easterly at about 12° (Tolman) [1a]. The uppermost foot or so of bedrock may be softened by weathering. Although removal of Eocene bedrock might require light blasting, Miocene bedrock probably can be removed by heavy, powered equipment.

B-4. Overburden materials are sandy clay or silt and clay that have weathered residually from bedrock, slope wash that is derived from the weathered bedrock, topsoil, and a small amount of alluvium. A poorly developed shallow swale, about 200 to 500 feet wide, is at the base of the right abutment and the right side of the valley floor. During months of heavy precipitation, water stands in this swale. A thin layer of loose sand and gravel alluvium is at the bottom of the stream channel. A 20-foot high dike will be built across the northern part of the reservoir at Sand Hill Road. It is underlain by Eocene bedrock and about 6 feet of overburden.

SOILS

B-5. FOUNDATION CONDITIONS

The foundation materials for the dam are overburden materials consisting of sandy clay or silt and some clay. Some unsuitable foundation material underlies the dam embankment. The unsuitable material is a dark gray to black, fat clay which when dry develops cracks 1 to 2 inches wide and more than 1-foot deep. The overburden materials range in thickness of from 10 feet on the abutments to 15 feet across the valley floor and are underlain by sandstone and shale bedrock. Stripping and removal of unsuitable material to a depth of 3 feet will be required over the foundation areas except for an area on the valley floor at the base of the right abutment. An estimated five feet of unsuitable material will be removed from this area which varies from 200 to 500 feet in width. Strippings and unsuitable materials will be wasted. The bottom of the cutoff trench will be in good quality bedrock. On both abutments it will be an estimated 10 feet below natural ground, and across the valley floor it will be approximately 15 feet below natural ground. The conduit will be founded on good quality bedrock about 100 feet to the left of the centerline of the stream at the axis. Spillway excavation will require the wasting of the top 3 feet of topsoil and other unsuitable material, removal of an additional 7 feet of overburden, and soft, easily erodable bedrock to invert grade. Approximate depths of excavations for the spillway, conduit and cutoff trench are shown on the Typical Sections, Plate B-2. The dike at Sand Hill Road will require the stripping and wasting of the top one-foot of overburden beneath the embankment and the removal of an additional 5 feet of overburden to good quality sandstone for the cutoff trench.

B-6. Cut slopes in areas that later will be covered by embankment will be 1-1/2 horizontal to 1 vertical through overburden and 1/2 horizontal to 1 vertical through bedrock. Cut slopes in areas that later will not be covered by embankment, such as the spillway and the conduit inlet and outlet channels will be 3 horizontal to 1 vertical through overburden and 1 horizontal to 1 vertical through bedrock. Grouting of a cutoff curtain under the foundation is considered unnecessary for the following reasons. The cutoff trench will be excavated through the overburden and weathered bedrock to good quality bedrock. Outcrops of the Eocene and Miocene sandstone and shale fail to show evidence of excessive permeability of the bedrock and fractures appear to be clay-filled which will reduce the effectiveness of any cement-grout. The downstream portion of the foundation area will have an overlying filter-graded drainage blanket and toe-drain that will safely remove excessive percolation and control hydrostatic uplift pressures. The relatively impervious overburden in the reservoir is considered to be at least six feet thick and will act as an upstream blanket to increase the path of percolation of water beneath the dam.

B-7. DETAILS OF EMBANKMENT SECTIONS

Since no subsurface exploration was made of the foundation and borrow materials, no physical data including soils tests have been developed for embankment design. The embankment sections and extent of excavation adopted for this report have been assumed, based on experience with similar conditions, and are believed to be adequately conservative for a quantity and cost estimate that would not be exceeded. The dam will be constructed of impervious materials except for the drainage elements. The upstream slope will be 1 vertical to 4.0 horizontal and the downstream slope will be 1 vertical to 3.0 horizontal. The drainage elements will consist of a 5-foot thick horizontal drainage blanket placed under the downstream portion of the dam and will connect to an 8-foot wide vertical chimney drain located just downstream from the centerline of the dam. The drainage blanket and chimney drain will consist of filter-graded sand and gravel. A shallow drainage trench containing a perforated metal pipe and backfilled with filter-graded sand and gravel will be located along the downstream toe. The drainage trench will be excavated to an average depth of 3.0 feet below the stripped foundation. The upstream slope will be protected from wave action by 15 inches of riprap placed on a 6-inch filter-graded sand and gravel blanket. The downstream slope will be seeded to protect it from surface erosion. A typical section of the dam is shown on Plate B-2.

B-8. The closure dike along Sand Hill Road will be constructed entirely of impervious materials with the same slopes as the dam. As water will be against this dike for only a very short duration, seepage will not be developed through the embankment and drainage elements such as vertical chimney drain, horizontal drainage blanket or toe drain will not be included in this structure. The reservoir side of the dike will be protected from wave action by 15 inches of riprap on 6 inches of filter-graded sand and gravel and the landside slope will be seeded.

CONSTRUCTION MATERIALS

B-9. IMPERVIOUS EARTHFILL

Approximately 1,800,000 cubic yards of compacted impervious fill is required for the embankment. The source of impervious borrow is immediately upstream from the axis of the proposed dam and is located in the reservoir area. The location of the borrow area is shown on Plate B-1. The borrow materials consist of sandy clay and silts overlying the sandstone bedrock. Depth of the impervious materials is not known. However, examination of road cuts and exposed stream channel banks indicates that there is an average of 6 feet of suitable material. The average haul distance for the impervious material is approximately 5,000 feet. It is assumed that the impervious sandy clay and silts have a sheer strength of 26 to 28 degrees and that the foundation strength will not be less. Using this assumed shear strength and the condition of sudden drawdown of the reservoir, the slopes of the dam would be 1 vertical to 4 horizontal upstream and 1 to 3 horizontal downstream.

B-10. CONCRETE MATERIALS

Cement for this project will be Type II with the alkali content not in excess of 0.6 percent in the amount of approximately 25,000 barrels. Cement can be obtained from any one of several commercial sources in the San Francisco Bay Area and delivered to the site by truck.

B-11. Concrete aggregate in the amount of approximately 28,000 tons will be required for this project. Concrete aggregate of approved quality can be obtained from commercial sources in the Niles-Centerville area and delivered by truck to the site, a distance of 17 to 19 miles of asphalt pavement across the Dumbarton toll bridge. These sources previously have been investigated and approved for use with cement having an alkali content not in excess of 0.6 percent for the San Leandro River and San Lorenzo Creek projects by the U.S. Army Engineer District, San Francisco, and are assumed to be the source for this project for cost estimating purposes.

B-12. FILTER SAND AND GRAVEL

Filter sand and gravel in the amount of approximately 315,000 tons will be required for this project. Material of suitable quality and quantity is available from the same commercial sources in the Niles-Centerville Area as for concrete aggregate. Haul distance is 17 to 19 miles of asphalt pavement across the Dumbarton toll bridge. For estimating purposes, sources in the Niles-Centerville Area will be considered as the approved sources of filter sand and gravel.

B-13. Commercial sources of the Santa Clara Sand and Gravel Company plant No. 3 and the Songroth Sand and Gravel Company are in the Santa Clara Gravel formation in the Stevens Creek Reservoir Area, about 11 miles of asphalt-paved haul road from the damsite. No service record or laboratory results of these tests are available for this material but with suitable processing these gravel materials appear capable of supplying the required filter sand and gravel. The material, in-place, contains an excessive amount of fines and will require processing in excess of that presently conducted by suppliers in the area. In addition, there are undeveloped resources of the same Santa Clara Gravel formation in this area and to the northward.

B-14. RIPRAP

Riprap in the approximate amount of 62,000 tons will be required. The Dempsey and Giles quarry in the NE ¼ sec. 18, T. 7 S., R. 3 W., about a mile west of State Highway Route No. 5 (Skyline Boulevard), a haul distance of 13 miles from the damsite, has been assumed the source of riprap for this report. The rock principally is basalt in the form of flows or intrusion into well indurated sandstone. The basalt is badly fractured and near the surface is badly weathered; however, a short distance below the surface the basalt is hard and sound. Strata of silicified and well-endurated sandstone are at the west end of the quarry. The hillside has been opened intermittently over a distance of 400 feet with a 60-foot high fence. It is estimated that an ample quantity of satisfactory quality rock can be produced from this quarry in the sizes required for the 15-inch thick riprap.

B-15. The commercial Brisbane quarry of the Pacific Cement and Aggregate Company, at Brisbane, California, a haul distance of 32 miles from the damsite, produces riprap which has a satisfactory service record. Possible, but unexplored, riprap sources are in the general vicinity of the damsite.

REFERENCES

SELECTED REFERENCES:

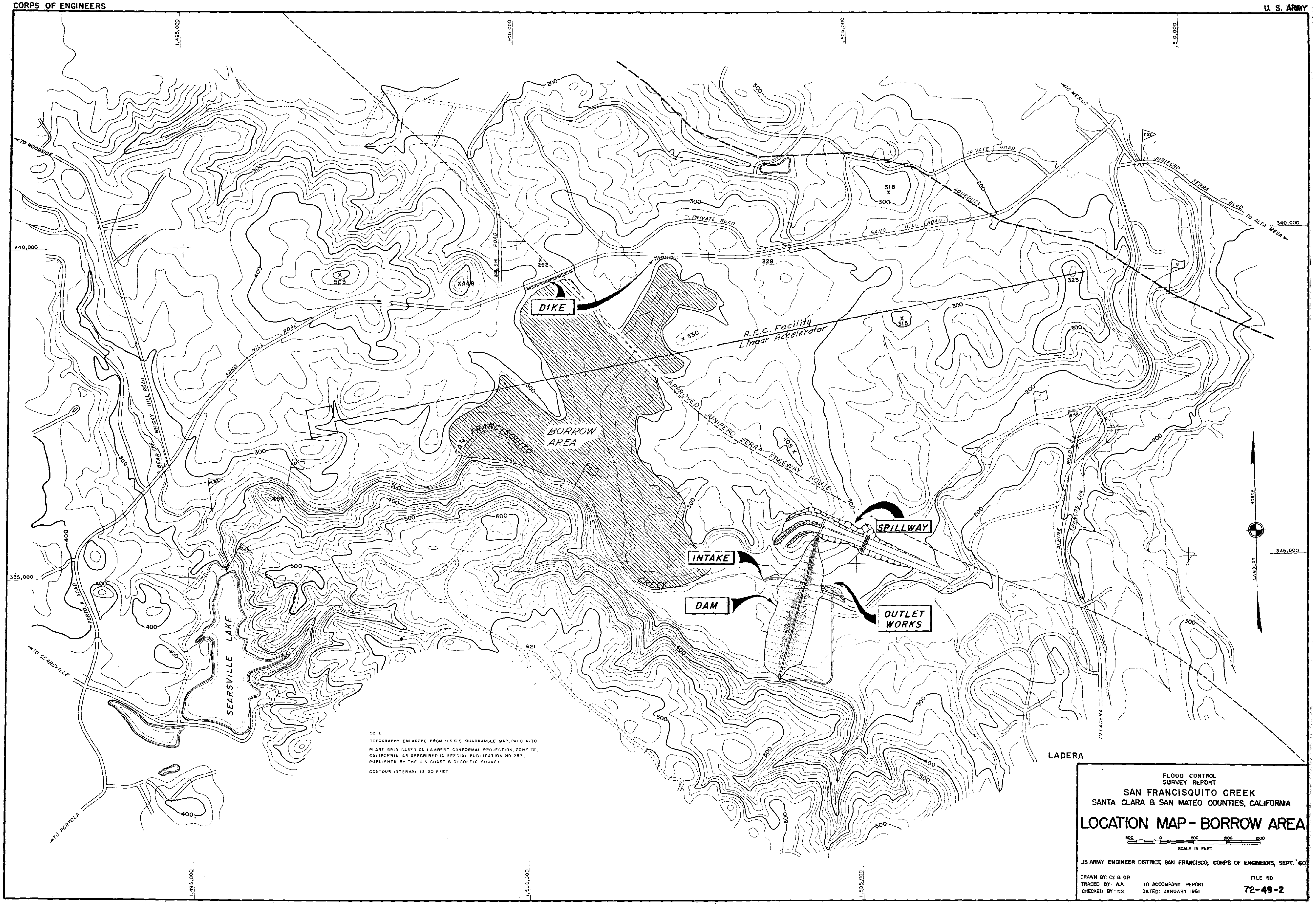
1/ Stanford University reports and maps assembled during study of Little Francis damsite in 1934.

1a/ Tolman, C. F., "Geological Report on San Francisquito Damsite, Stanford University, California" (typescript), 16 pp., 4 maps, 25 July 1934.

1b/ Rawhauser, J. G., & Poland, J. F., "Report on Physical Examination of Materials in the vicinity of San Francisquito Dam" (typescript), 8 pp., tables, charts, March 1934.

2/ Davis, Fenelon F., "Mines and Mineral Resources of San Mateo County, California", California Division of Mines, Journal of Mines and Geology, volume 51, No. 4, pp. 401-458, geologic map scale about 1 inch = 2 miles, October 1955.

3/ Lawson, A. C., "San Francisco, California", Geologic Atlas 193, 1914. (Tamalpais, San Francisco, Concord, San Mateo, Hayward quadrangles, scale 1:62,500).



NOTE

TOPOGRAPHY ENLARGED FROM U.S.G.S. QUADRANGLE MAP, PALO ALTO.

PLANE GRID BASED ON LAMBERT CONFORMAL PROJECTION, ZONE III, CALIFORNIA, AS DESCRIBED IN SPECIAL PUBLICATION NO. 253, PUBLISHED BY THE U.S. COAST & GEODETIC SURVEY.

CONTOUR INTERVAL IS 20 FEET.

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA

LOCATION MAP - BORROW AREA

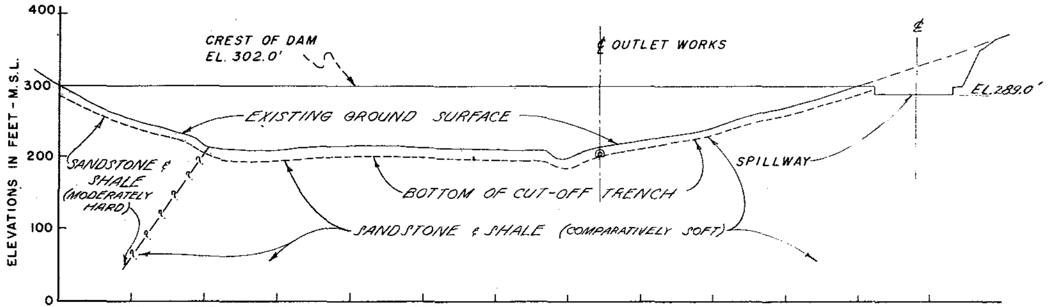
500 0 500 1000 1500
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS, SEPT. '60

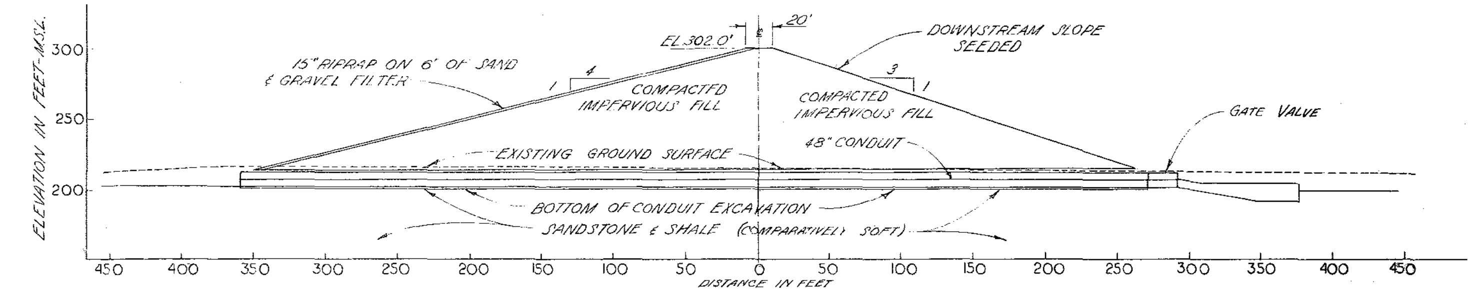
DRAWN BY: C.Y. & G.P.
TRACED BY: W.A.
CHECKED BY: N.S.

TO ACCOMPANY REPORT
DATED: JANUARY 1961

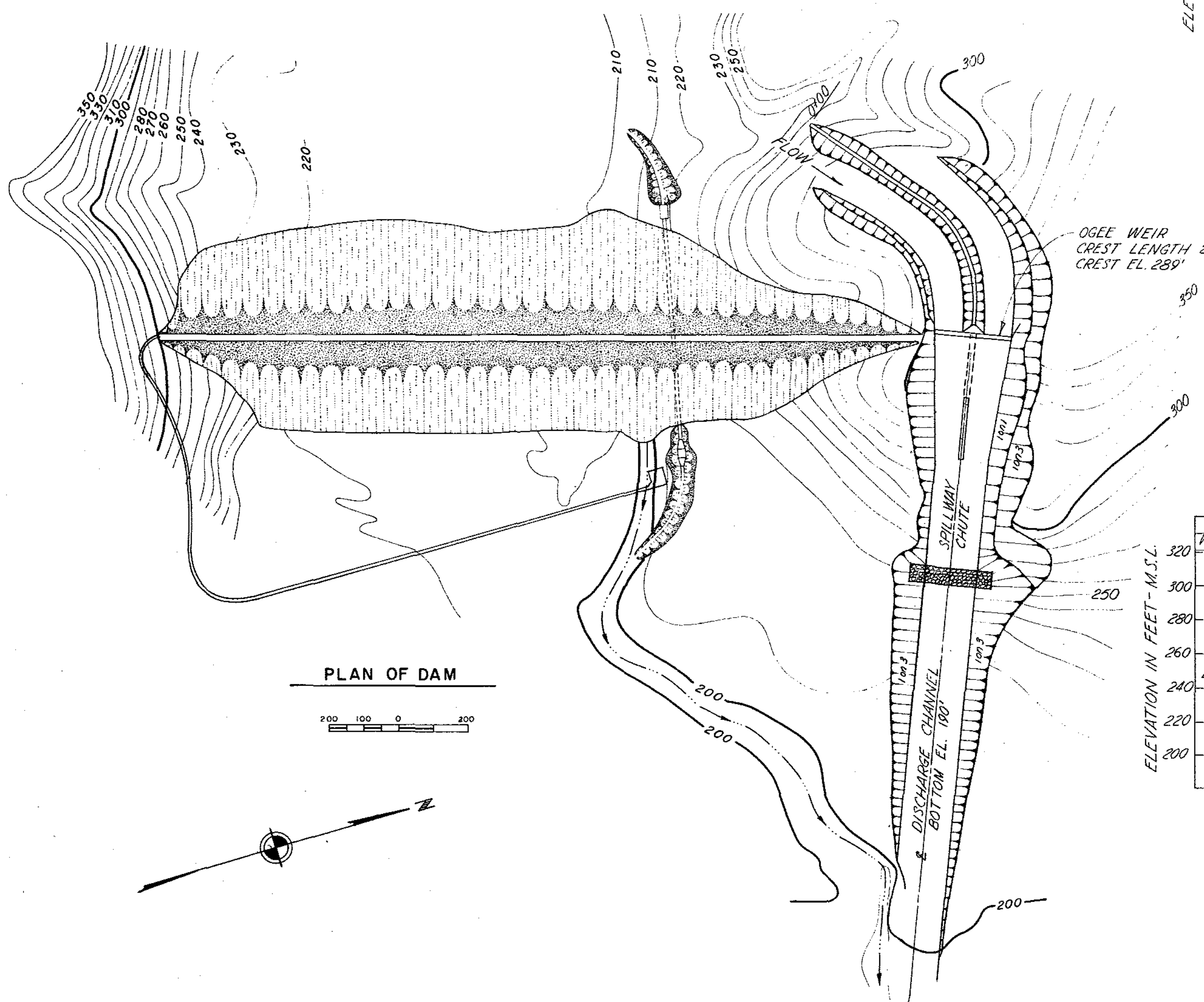
FILE NO.
72-49-2



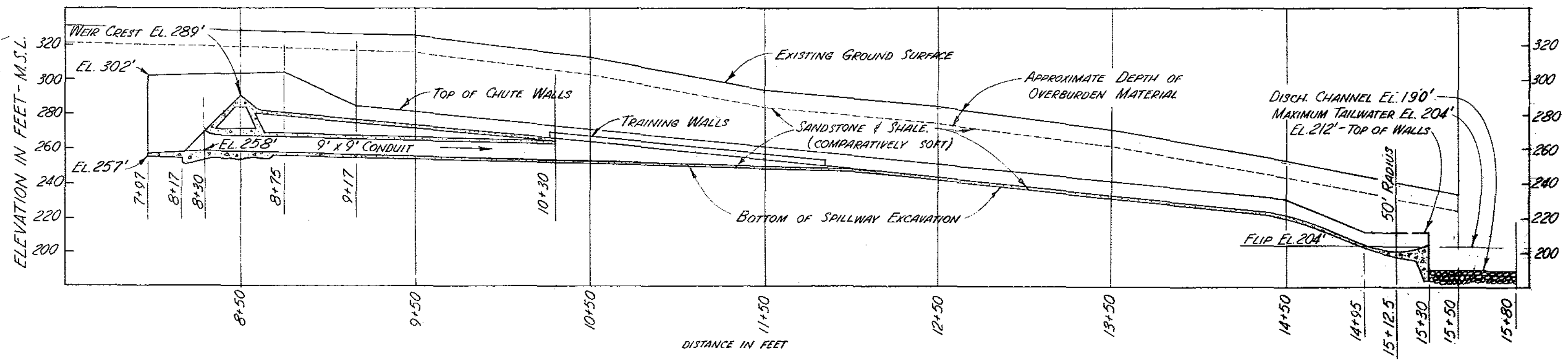
PROFILE AT AXIS OF DAM


EL. 302.0'
20'
DOWNSTREAM SLOPE SEEDED
15" RIPRAP ON 6' OF SAND & GRAVEL FILTER
1
4
3
1
COMPACTED IMPERVIOUS FILL
COMPACTED IMPERVIOUS FILL
GATE VALVE
EXISTING GROUND SURFACE
48" CONDUIT
BOTTOM OF CONDUIT EXCAVATION
SANDSTONE & SHALE (COMPARATIVELY SOFT)
ELEVATION IN FEET - M.S.L.
300
250
200
450
400
350
300
250
200
150
100
50
0
50
100
150
200
250
300
350
400
450
DISTANCE IN FEET

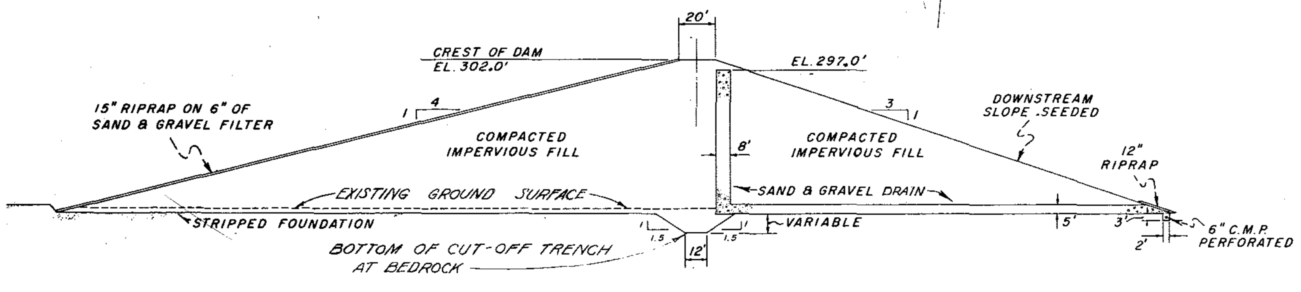
PROFILE AT CENTERLINE OF OUTLET CONDUIT



PLAN OF DAM



PROFILE AT CENTERLINE OF SPILLWAY



TYPICAL SECTION

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA

PLAN AND SECTIONS

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS, SEPT. '60

DRAWN BY: C.Y.
TRACED BY: WA
CHECKED BY: N.S.

TO ACCOMPANY REPORT
DATED: JANUARY 1961

FILE NO.
72-49-2

PLATE B-2

REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK,
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX C

PLAN OF IMPROVEMENT, COST ESTIMATES AND COST ALLOCATIONS

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REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK,
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX C

PLAN OF IMPROVEMENT, COST ESTIMATES AND COST ALLOCATIONS

GENERAL

C-1. SCOPE

This appendix describes the engineering aspects of a plan of improvement for San Francisquito Creek, California, for flood control and allied purposes; presents estimates of first costs and annual charges; and presents an allocation of costs between project purposes and between the Federal Government and local interests. The location and details of the improvements considered are shown on Plate 3 to the main report.

PROPOSED IMPROVEMENTS

C-2. SELECTION

Studies and investigations have shown that providing protection against the standard project flood on San Francisquito Creek is not economically feasible at this time. The broad considerations governing the selection of the most practicable plan of improvement are that it must provide:

(a) Minimum disturbance to the regimen of the basin.
(b) Maximum effectiveness in the areas when damages are concentrated.
(c) Minimum interference with existing developments and facilities.
(d) Maximum overall benefits.
(e) Maximum opportunity for collateral benefits and multiple-purpose use of improvements.
(f) Benefits commensurate with the cost.

C-3. SOLUTION CONSIDERED

Means other than the proposed plan of improvement were considered as possible solutions to control flood runoff through the highly urbanized flood plain area. Essentially, these works consisted of the following:

(a) Improvements by widening and deepening the channel.

(b) Levees.

(c) Bank-protection works including flood walls, sacked concrete, revetments and concrete lining.

(d) Combination of reservoir and channel works affording the same benefits as the flood-control feature of multiple-purpose project.

None of the works in (a) to (c) above proved to be economically justified for adequately protecting the urbanized area. With regard to the last-listed alternative, it was found that a combination reservoir of smaller capacity and channel works would be less feasible than the proposed plan of improvement.

C-4. ADOPTED PLAN

The selected plan consists of a multiple-purpose reservoir of 12,600 acre-feet of gross storage with 8,500 acre-feet allotted for flood control, 3,500 acre-feet for water conservation and 600 acre-feet for siltation. The full flood-control storage would be utilized during the months, November to April. During the remainder of the year the flood-control storage area would be made available for collateral, public-use recreational facilities in the best public interest subordinate to the project purposes. The reservoir and appurtenant works would be maintained and operated by local interests. A hydrologic network for collection of data on precipitation and streamflow would be established and maintained for obtaining information necessary to assure proper evaluation of the flood-control features of the reservoir.

C-5. The proposed reservoir would be formed by a dam on San Francisquito Creek at mile 10.2, approximately 2.5 miles downstream from Searsville Lake and would not encroach on Searsville Lake. The upper limits of the reservoir corresponding to the maximum surcharge pool would be at about mile 12.4. The area within these limits includes eight homesites north of Sand Hill Road, and some 400 acres of grazing lands south of Sand Hill Road.

C-6. The principal features of the reservoir would be: (a) an earth dam with crest at elevation 302 m.s.l. across San Francisquito Creek at mile 10.2; (b) an ungated spillway including an ungated conduit near the left abutment for releases of flood flows with a flip bucket at the bottom of the chute; (c) outlet works through the dam near the left abutment with a capacity of 100 to 500 c.f.s. for water-supply and low flood-control release; (d) two earth dikes parallel to Sand Hill Road as indicated on Plate C-2; and (e) relocation of county roads which would be in the reservoir area.

C-7. FEATURES OF THE DAM

The damsite has a wide, relatively level bottom. The dam would be a rolled-earth structure and would have a height above the streambed of

95 feet and a length of about 2,200 feet at its crest. The earth-fill type of dam was adopted since it was found that other types would be more costly. Other factors favoring the earth-fill type are the availability of materials for construction, and the probability of earthquakes in the zone in which the site is located. The plan and details of the dam are shown on Plate 3 to the main report.

C-8. The dam with crest at elevation 302 would have a top width of 20 feet; upstream side slopes of 1 vertical on 4 horizontal and downstream slopes of 1 vertical on 3 horizontal. The dam would be constructed of impervious materials extending into a core trench except for the drainage features. These features would include a five-foot thick, horizontal drainage blanket placed under the downstream portion of the dam and connected to an eight-foot wide vertical chimney drain. These components would consist of filter-graded sand and gravel. The downstream toe of the dam would be provided with a toe drain and collector pipes. The upstream sloping face of the dam would be protected with a 15-inch layer of riprap underlain with a six-inch filter blanket. A 12-foot bituminous-surface road for access to the outlet works would be constructed on the crest of the dam.

C-9. The adopted section and the extent of excavation was based on information in reports prepared for Standord University as discussed in Appendix B, Geology, Soils and Construction Materials.

C-10. Impervious borrow required for the earth dam would be obtained from within the reservoir area immediately upstream from the axis of the proposed dam. Filter material (sand and gravel) of suitable quality and quantity is available from commercial sources with a haul distance of about 19 miles. Riprap can be obtained from a commercial source about one mile west of State Highway Route No. 5 (Skyline Boulevard), a haul distance of 13 miles from the damsite.

C-11. SPILLWAY APPROACH CHANNEL

The alignment of the approach channel was designed with the objective of providing a channel to the flood-control outlet through the spillway weir and also provides smooth flow over the spillway weir crest. The bottom of the flood-control conduit would be constructed at elevation 258 feet m.s.l. The spillway approach channel invert would be 281 m.s.l. and its width would vary from about 250 feet to 220 feet at the spillway weir. The approach channel would be excavated into bedrock for its entire length. The flood-control outlet channel would be lined with reinforced concrete 16 inches thick for a distance of 20 feet upstream to provide a transition into the conduit.

C-12. SPILLWAY

The spillway would be located in the left abutment of the earth dam. It would have a concrete ogee weir with its crest at the top of the static flood-control pool (289 m.s.l.). A concrete conduit nine feet square would be constructed through the ogee weir to provide for flood-control releases. The invert elevation of the conduit would be 258 m.s.l., the maximum conservation pool. The crown elevation of the conduit would be 267 feet m.s.l. An uncontrolled spillway with a flood-control outlet through the weir was selected because of the adequate automatic control that could be obtained. The terrain and improvements adjacent to the reservoir area limit the height to which the water surface may be raised and a dam may be economically built. Therefore, because of the limitation of the dam height, a 220-foot spillway crest length was selected. The spillway was designed to discharge with safety the spillway design flood, the derivation of which is discussed in Appendix A. Assuming the reservoir to be filled to the top of the conservation pool elevation 258 m.s.l. at the beginning of the flood, routing computations indicate that the spillway design flood would reach a maximum reservoir state of 297 feet m.s.l. with a maximum spillway discharge of 20,300 c.f.s. The maximum stage at or near the peak would have a duration of 11 hours. Ten hours after the maximum stage the water surface would be reduced five feet. As described in Appendix A, the spillway would effect about 25 percent reduction of the spillway design flood. A freeboard of about five feet, the minimum for this type of structure, would be provided in the reservoir to give elevation 302 m.s.l. as the adopted crest of dam. This freeboard was computed as the amount necessary to provide for wind setup, wave height, and ride-up which would be expected to result from a maximum wind velocity of 50 miles per hour over a fetch of one mile. General details of the spillway are shown on Plate 3 to the main report.

C-13. SPILLWAY CHUTE AND FLIP BUCKET

The spillway chute would have a width of 220 feet between the abutments, reducing to 150 feet wide at the end of the flood-control conduit. The bottom of the chute would be a reinforced concrete slab 16 inches thick for its length. A system of longitudinal drain and collector pipes would installed to discharge any seepage water that might otherwise collect and produce excessive pressures. The walls of the chute and flip bucket were designed as cantilever retaining walls to withstand natural drained pervious soil conditions behind and to the top of the walls and the chute under either full or empty channel conditions. Excavation for the walls would be backfilled with pervious material. Details of the chute and flip bucket are shown on Plate 3 to the main report.

C-14. An outlet channel extending from the flip bucket to the main creek channel would be constructed for the purpose of directing the spillway discharge to the creek. The channel would be trapezoidal with a bottom width of 150 feet and side slopes of 1 vertical on 3 horizontal. The maximum velocity for the spillway design discharge would be under 10 f.p.s. The outlet for the channel would be located away from the toe of the dam to prevent damage to the embankment.

C-15. RESERVOIR OUTLET WORKS

The location of the outlet-control works is shown on Plate 3 to the main report. Considering the topography and the foundation material, the most feasible location of the outlet structure was found to be about 100 feet left of the centerline of the stream at the axis. These works would be placed on bedrock and comprise an intake structure, a pressure conduit, downstream control system, a stilling basin and outlet channel. Because of the lack of soils investigations the stilling basin has been included pending an adequate determination of site conditions. The intake, a reinforced concrete structure 13 feet long, 11 feet wide and seven feet high would consist of a trash rack, stoplogs and two 36-inch hydraulically operated emergency gates. The hydraulic controls for the gates would be located on the crest of the dam. These would consist of two hand-operated hydraulic pumps and appurtenances housed in a reinforced-concrete structure eight feet long, six feet wide, and four feet high. The choice of this type of outlet works is predicated upon its successful use throughout the area by the Santa Clara County Water Conservation District.

C-16. The conduit would be a circular 48-inch diameter one-quarter-inch thick welded steel plate encased in concrete, and it would have a total length of about 700 feet with its inlet invert at elevation 204 feet mean sea level. Concrete cutoff collars would be installed at intervals of 20 feet along the conduit. The conduit would have an estimated maximum capacity of about 500 c.f.s., and would be capable of emptying the reservoir from elevation 258 feet mean sea level, the invert of the flood-control conduit, in about seven days, assuming no inflow. The 48-inch conduit would have an estimated capacity of 100 c.f.s. under about two feet of head. This would provide the maximum required water-conservation release. The selection of the 48-inch conduit is considered minimum for convenience of maintenance.

C-17. The control system would be located at the downstream end of the conduit and would consist of valves for small flood-control and regular water-conservation releases which would discharge into a stilling basin. This basin would be 16 feet wide and 30 feet long in order to develop a hydraulic jump for the maximum design flow of 500 c.f.s. The bottom of the stilling basin would be at elevation 193 feet m.s.l., or approximately seven feet below the invert of the outlet channel which is at elevation 200 feet m.s.l. Three feet of freeboard would be provided, making the top of the stilling basin walls at elevation 207 feet m.s.l. A raised end sill would be provided in the stilling basin as a means of reducing the length and depth of the basin. A system of gravel drains and collector pipes would be installed under the slab and behind the walls. These would be inter-connected to discharge seepage water through openings in the floor slab. The end sill would be protected with riprap for a distance of 50 feet from the sill. A trapezoidal outlet channel with a bottom width of ten feet and side slopes of 1 vertical on 3 horizontal would be constructed to convey the outlet discharge to the creek. The maximum velocity for the maximum design discharge in the channel would be about nine feet per second.

C-18. CLOSURE DIKES

Closure dikes adjacent to Sand Hill Road would be constructed of impervious materials with slopes the same as the dam. The slopes on the reservoir side of the dike would be protected with 15 inches of riprap on a six-inch filter. The land side slope would be seeded. The dike would have its crest at elevation 302 feet m.s.l., the same as the main dam. The top width of the dike would be 12 feet.

C-19. RELOCATIONS

Three-tenths of a mile of Whiskey Hill Road located within the proposed reservoir area would be relocated or raised. The two-tenths of a mile of Sand Hill Road crossing the reservoir would be raised to elevation 302 feet mean sea level, crest of dam elevation. The existing roads are shown on Plate 2 to the main report.

C-20. Approximately 2.5 miles of 12-inch waterline affected by the reservoir would require relocation. This relocation would be accomplished by constructing a new pipeline through the reservoir area. This pipeline would take off from the existing line at a point downstream from Searsville dam at an elevation above the proposed maximum water surface. The relocated pipeline would connect to the existing waterline downstream of the dam. The existing waterline in the reservoir area would be abandoned.

C-21. LAND ACQUISITION

The acquisition of about 525 acres of land would be required for the reservoir area and relocation and modification of Whiskey Hill and Sand Hill Roads. In addition, 57 acres of land would be required to provide for the integration of the basic public use facilities with the flood-control feature.

C-22. MISCELLANEOUS

A 12-foot wide bituminous-surfaced access road would be constructed from Alpine Road to the outlet works and the crest of the dam. The reservoir area would be cleared of all trees and improvements which would interfere with the proper functioning of the reservoir. Existing communications and power lines which would be affacted by the reservoir would be relocated as required.

C-23. The proposed interstate highway, the approximate location of which is shown on Plate 2 as the approved Junipero Serra Freeway route, has been coordinated with the California Division of Highways. Its location as shown will have no adverse effects on the reservoir project. Continued coordination with the Division of Highways and the Atomic Energy Commission will define the specific location prior to the design stage.

C-24. It has been estimated that the reservoir project could be completed in about two years after initiation of construction. The outlet works would be constructed first and would provide for the diversion of streamflow during construction. However, the creek is usually dry during May through October and the average flow after 15 April and before 15 November is less than 50 c.f.s. Construction could be scheduled so that final closure of the dam could be made while flow in the creek was small. The expected small flow of underground water into the cutoff trench could be handled by well points surrounding the excavation.

C-25. SUMMARY OF RESERVOIR DATA

A summary of pertinent data pertaining to the proposed project for San Francisquito Creek is given in the following tabulation:

SUMMARY OF PERTINENT DATA

Item	Quantity
General	
Drainage area	
Above former Palo Alto gage	38.4 square miles
Above proposed dam	28 " "
Reservoir storage at spillway crest elevation 289 m.s.l.	12,600 acre-feet
Principal Features	
Main dam (earthfill)	
Crest elevation	302 feet mean sea level
Height above stream bottom	95 feet
Depth, overburden:	
At foundation abutments	10 feet
At valley floor	15 feet
Width and length of crest	20 feet by 2,200 feet
Upstream side slope	1 vertical on 4 horizontal
Downstream side slope	1 vertical on 3 horizontal
Freeboard above spillway design flood-water surface	5 feet
Spillway, on left abutment (ungated concrete ogee weir):	
Crest length, gross	220 feet
Crest elevation	289 feet mean sea level
Outlet (near left abutment):	
Diameter and length of conduit	4 feet by 700 feet
Inlet invert elevation	204 feet mean sea level
Capacity of conduit with reservoir level at elevation top of conservation pool, 258 m.s.l.	415 c.f.s.
Capacity of conduit with reservoir level at pool elevation, 210 m.s.l.	100 c.f.s.

SUMMARY OF PERTINENT DATA (continued)

Item	Quantity
Principal Features (continued)	
Dikes (earthfill)	
Crest elevation	302 feet mean sea level
Average height above ground	15 feet
Width and total length	12 feet x 1,200 feet
Side slopes	1 vertical on 3 horizontal
Relocations:	
County roads	0.5 mile
12-inch waterline	2.5 miles

Reservoir

Storage allocations:	
Flood control	8,500 acre-feet
Water conservation	3,500 " "
Sediment	600 " "

Hydraulic

Reservoir design flood:	
Peak inflow	7,500 c.f.s.
Release (variable):	
Maximum	2,000 c.f.s.
Maximum flood-control volume stored	8,500 acre-feet
Maximum water surface elevation	289 feet mean sea level
Standard Project Flood:	
Peak inflow	11,000 c.f.s.
Peak outflow	5,400 c.f.s.
Surcharge storage above flood-control pool	1,000 acre-feet
Maximum flood-control volume stored	9,500 acre-feet
Maximum water surface elevation	292 feet mean sea level
Maximum probable flood:	
Peak inflow	27,000 c.f.s.
Peak outflow	20,300 c.f.s.
Spillway design flood:	
(Same as maximum probable flood)	
Surcharge storage above flood-control pool	3,300 acre-feet
Maximum flood-control volume stored	11,800 " "
Maximum water surface elevation	297 feet mean sea level

ESTIMATE OF COST

C-26. BASIS FOR ESTIMATE OF COST

The cost estimates in this report were prepared on the basis of unit costs prevailing in November 1959. All estimates include allowances for contingencies, engineering, and supervision and administration. Construction of the proposed San Francisquito Creek reservoir would require about two years.

C-27. Unit prices were determined by analyzing unit bid prices for similar types of work under comparable conditions, and modified as required to reflect proposed project conditions. Highway U. S. 101, Bayshore Freeway, and the main coastline of the Southern Pacific Company are within ten miles of the damsite. Existing county roads provide ready access to the damsite from the main highways and Southern Pacific Company's mainline. The availability of materials required for the construction of the project is discussed in Appendix B, Geology, Soils and Construction Materials.

C-28. LAND ACQUISITION

All lands, easements, and rights-of-way for the proposed reservoir, road relocations and utilities would be paid for by local interests. The estimate of costs for acquiring the necessary lands was prepared by the Real Estate Division, San Francisco District, Corps of Engineers. In preparing the cost estimate for this project it was assumed that all lands lying within the reservoir area would be acquired in fee simple since easements are expected to be practically the same cost.

C-29. PUBLIC RECREATIONAL FACILITIES

As conceived in this report the provision of basic public use facilities for recreation would be provided at Federal expense for land and construction based on the Authority of the 1946 Flood Control Act. The costs and description of the public use facilities are given in the National Park Service's letter of September 12th, Appendix "F". Under the proposed project concept, the benefits that might be derived from the public use recreational facilities are considered to be collateral to the primary project purposes and therefore are not included in the allocation of costs or in the determination of the benefit-to-cost ratio for the proposed project.

C-30. FIRST COST

A summary and an estimate of first costs are given in the tabulations which follow:

a. Summary of first costs.

Cost Account No.	Feature	Amount	Total with distributed E+D & S+A
01	Lands and damages	$2,570,000	$2,570,000
02	Relocation	215,000	255,000
03	Reservoir	172,000	204,000
04	Dam	3,969,000	4,675,000
08	Access roads	41,000	50,000
30	Engineering and design costs (includes overhead)	415,000	-
31	Supervision and administration	372,000	-
	Subtotal, first cost	$7,754,000	$7,754,000
14	Recreational facilities	635,000	635,000
29	Preauthorization studies	76,000	76,000
	Total, project cost	$8,465,000	$8,465,000

b. Cost estimate

San Francisquito Creek Reservoir

Item No.	Item	Quantity	Unit	Unit Price	Amount	
					Subtotal	Total
	GENERAL					
1	Access road		Mi.		35,000	
2	Clearing of reservoir area	300	Acre	$500.00	150,000	
4	Diversion and care of water		L.S.		25,000	
5	Hydrological network for flood control		L.S.		10,000	
6	Contingencies				33,000	
	Subtotal, General					$ 253,000
	MAIN DAM					
7	Stripping	189,600	C.Y.	.40	75,800	
8	Excavation for core	9,800	C.Y.	.75	7,400	
9	Embankment in place	1,793,700	C.Y.	.60	1,076,200	
10	Sand and gravel drains and filter blanket	306,900	Ton	3.00	920,700	
11	Riprap	51,000	Ton	4.00	204,000	
12	Toe drains	2,200	L.F.	2.50	5,500	
13	Seeding	12	Acre	800.00	9,600	
14	Contingencies				344,800	
	Subtotal, Main Dam					$2,644,000
	SPILLWAY					
15	Stripping	27,300	C.Y.	.40	10,900	
16	Excavation, common	156,800	C.Y.	.40	62,700	
17	Excavation, classified	458,800	C.Y.	.60	275,300	

Cost Estimate (continued)

Item				Unit	Amount	
No.	Item	Quantity	Unit	Price	Subtotal	Total
	SPILLWAY (Cont'd.)					
18	Backfill	8,300	C.Y.	$ 1.50	$ 12,500	
19	Concrete, including reinforcing steel	9,600	C.Y.	44.00	423,200	
20	Sand and gravel filter	5,300	Ton	3.00	15,900	
21	Collector drains	2,400	L.F.	4.00	9,600	
22	Riprap	4,100	Ton	6.00	24,600	
23	Fence, 4' chain link	1,620	L.F.	2.50	4,100	
24	Contingencies				126,200	
	Subtotal, Spillway					$965,000
	OUTLET WORKS					
25	Excavation, common	9,000	C.Y.	.40	3,600	
26	Excavation, structural	2,500	C.Y.	3.50	8,800	
27	Backfill, hand	400	C.Y.	3.00	1,200	
28	Sand and gravel filter	2,100	Ton	3.00	6,300	
29	Riprap	4,800	Ton	4.00	19,200	
30	Concrete, including reinforcing steel	1,200	C.Y.	60.00	72,000	
31	Structural steel	12,000	Lbs.	.75	9,000	
32	Pipe, welded steel 48" x 1/4"	675	L.F.	50.00	33,800	
33	Emergency gates (2-36" hydraulically operated)	2	Ea.	17,000	34,000	
34	Control gate - 48"		L.S.		30,000	

Cost Estimate (continued)

Item No.	Item	Quantity	Unit	Unit Price	Amount	
					Subtotal	Total
35	Miscellaneous metal	2,500	Lbs.	$ .60	$ 1,500	
36	Mechanical equipment		L.S.		10,000	
37	Electrical equipment		L.S.		5,000	
38	Shelter	200	S.F.	15.00	3,000	
39	Drains	200	L.F.	4.00	800	
40	Fence, 4' chain link	800	L.F.	2.50	2,000	
41	Contingencies				35,800	
	Subtotal, Outlet Works					$276,000
	CLOSURE DIKE					
42	Stripping	2,300	C.Y.	.40	900	
43	Embankment in place	49,600	C.Y.	.75	37,200	
44	Contingencies				5,900	
	Subtotal, Closure Dike					$ 44,000
	RELOCATION					
45	12" water line (2.5 mi.)	13,200	L.F.	9.00	118,000	
46	Valves and vents	3	Ea.	650.00	1,900	
47	Electric power line		L.S.		25,000	
48	County roads (0.5 mi.)		L.S.		40,000	
49	Contingencies				28,500	
	Subtotal, Relocations					$215,000

Cost Estimate (Continued)

Item No.	Item	Amount Subtotal	 Total
	Total cost, dam and appurtenant works		$4,397,000
50	Lands and damages		2,570,000
	Total, direct cost		$6,967,000
51	Engineering and design costs (includes overhead)		415,000
52	Supervision and administration		372,000
	Subtotal, first cost		$7,754,000
53	Basic public use facilities		
	Land		$ 285,000
	Construction a/		350,000
	Total, first cost		$8,389,000
54	Preauthorization studies		76,000
	Total, first cost		$8,465,000

a/ Breakdown of costs given in National Park Service's letter dated September 12, 1961 in Appendix "F".

C-31. REPLACEMENTS

Estimates of annual replacement costs were based on an economic life of the project of 50 years. Some of the shorter life features would require replacement during the life of the project. The service gates, emergency gates and valves for the outlet works were the principal items assigned a 30-year life.

C-32. MAINTENANCE AND OPERATION

Annual maintenance and operation costs for the reservoir are based on use of percentages of first costs of various principal features of the project. This method presents a uniform basis for estimating annual costs, utilizing experience gained on similar projects constructed by the Corps of Engineers. These percentages are:

Item	
General field:	
Buildings, grounds and utilities	2.0 percent of first cost
Access road	2.0 percent of first cost
Main dam	$0.38 per acre-foot of capacity
Spillway:	
Concrete structure	0.2 percent of first cost
Outlet works:	
Gates and valves	1.0 percent of first cost

C-33. ANNUAL CHARGES

The estimate of annual charges has been based on an economic life of 50 years, a Federal interest rate of 2-5/8 percent per annum, and a non-Federal rate of four percent per annum. The Federal interest rate is taken from the latest information furnished by the Secretary of the Treasury. The non-Federal rate is representative of that being paid by local agencies in the San Francisco Bay area. As described under allocation of costs, local interests are to pay for the costs allocated to water conservation and to furnish all lands, easements, and rights-of-way allocated to flood control. It is estimated that the project can be constructed in about two years. The cost allocations as developed in subsequent paragraphs are given below:

Item	Flood control	Water conservation	Total
Federal:			
Construction	$4,112,000 a/	$ 0	$4,112,000 a/
Non-Federal:			
Construction	0	817,000	817,000
Lands, easements, relocations, etc.	2,354,000	471,000	2,825,000
Total, non-Federal	2,354,000	1,288,000	3,642,000
Total	$6,466,000	$1,288,000	$7,754,000
(Ratio to total)	(0.834)	(0.166)	(1.000)

a/ Excludes preauthorization survey cost of $76,000.

Total annual charges amount to an estimated $437,000 including $51,000 for maintenance and operation and major replacements. Of the total, $308,000 is chargeable to flood control, $72,000 to water conservation and $57,000 to the recreational facilities. Included in the total for recreational facilities are; $17,000 for land, $12,000 for construction and $28,000 for operation and maintenance and major replacements. The derivation of annual charges for the recreational facilities exclusive of land costs is presented in the National Park Service's letter of September 12th, Appendix "F". Annual charges for derivation of benefit-cost ratio amount to $377,000 (exclusive of costs of recreational facilities and preauthorization surveys), of which $306,000 is allocated to flood control, and $71,000 to water conservation. The derivation of these figures is given in the computations which follow:

a. Economic cost

Item	Flood Control	Water Conservation	Total
Federal:			
First cost	$ 4,112,000[a/]	0	$ 4,112,000
Interest during construction (½ of 2 years at 2-5/8%)	108,000	0	108,000
Federal investment	4,220,000	0	$ 4,220,000
Non-Federal:			
First cost	$ 2,354,000	$ 1,288,000	$ 3,642,000
Interest during construction (½ of 2 years at 4%)	94,000	52,000	146,000
Value of lands (included in above)	($2,085,000)	(415,000)	($2,500,000)
Non-Federal investment	$ 2,448,000	$ 1,340,000	$ 3,788,000
Total investment	$ 6,668,000	$ 1,340,000	$ 8,008,000

[a/] Excludes preauthorization survey cost of $76,000.

b. Annual maintenance and operation

The annual maintenance and operation costs were determined by application of the percentages to corresponding items as given in a preceding paragraph.

13/10 9/7 4/3 2/15 4/3 4/5 13/10

Item	Annual cost
Reservoir (main dam)	$ 10,000
Spillway	2,000
Outlet works	2,000
Buildings, grounds, access roads	1,000
Hydrologic network	5,000
Total	$ 20,000

c. Annual charge for major replacement

Item	Estimated number Replacements	Estimated cost per Replacement	Estimated Annual Cost
Outlet gates	1	$ 167,000	$ 3,000
Total			$ 3,000

d. Interest plus amortization and loss of land productivity.

(1) Flood control

Federal (I+A) = 0.03614 x $4,220,000 = $153,000

Non-Federal (I+A) = 0.04655 x $2,448,000 = $113,000

Adjustment for loss of land productivity:

(0.050 -0.040) x $2,085,000 = 21,000

Total, non-Federal 134,000

Total, flood control $287,000

(2) Water conservation

Non-Federal (I+A) = 0.04655 x $1,340,000 = $ 63,000

Adjustment for loss of land productivity:

(0.050 -0.040) x $415,000 = 4,000

Total, non-Federal $ 67,000

Total, project interest plus amortization $354,000

e. Total, annual charges.

Item	Flood control	Water conservation	Total
Federal:			
Interest plus amortization	$153,000	0	$153,000
Non-Federal:			
Interest plus amortization	134,000	$67,000	201,000
Maintenance and operation and replacements	19,000	4,000	23,000
Total, non-Federal	153,000	71,000	224,000
Total, project cost	$306,000	$71,000	$377,000
Preauthorization surveys (0.03614 x $76,000) =	2,000a/	1,000a/	3,000
Gross, total project	$308,000	$72,000	$380,000
Ratio to total	(0.811)	(0.189)	(1.000)

a/ Based on ratio to total.

ALLOCATION OF COST

C-34. BASIS OF ALLOCATION

All costs allocated to water conservation would be paid by local interests in accordance with Title III of Public Law 85-500 (Water Supply Act of 1958). For purposes of the report it was assumed that the water would be utilized upon completion of the project. Repayment to the Federal government would commence at that time. Local interests would also be required to pay for costs of lands, easements, rights-of-way and relocations, exclusive of the cost of recreational facilities which is to be at Federal expense for land and construction and maintain and operate the project for flood control including public recreational facilities and water conservation. Since the project would be constructed in lieu of local protection works, the requirements as given in the Flood Control Act for local cooperation in local protection works apply. Costs have been allocated between flood control and water conservation, the primary project purposes, by the "Use of Facilities Method" as prescribed in EM 1160-2-101. The relative storages were used as basis for allocating joint costs.

C-35. LEAST EXPENSIVE SINGLE-PURPOSE ALTERNATIVES

Separate studies were made to determine the least expensive alternative for any one purpose which would serve that purpose equally as well as the proposed multiple-purpose project. From these studies it was found that the Hetch Hetchy system could supply water for urban and industrial use at the least alternate cost. The cost of a 9,100 acre-foot single-purpose flood-control reservoir providing the same storage as the proposed multiple-purpose reservoir was estimated at $6,546,000, and the annual charge exclusive of preauthorization study costs but including maintenance, operation and replacement costs of $17,000 would be $310,000. Derivation of the annual cost follows:

First cost:

Construction		$4,171,000	
Interest during construction (2 x 2-5/8% x ½)		109,000	
			$4,280,000
Relocations	$205,000		
Interest during construction (2 x 4% x ½)	8,000		
		$ 213,000	
Lands and damages	$2,170,000		
Interest during construction (2 x 4% x ½)	87,000		
		$2,257,000	
			$2,470,000
Gross investment			$6,750,000

Annual charges:

Interest and amortization	
Construction (2-5/8% for 50 yrs.) (.03614 x $4,280,000)	$ 155,000
Relocations (4% for 50 yrs.) (.04655 x $213,000)	10,000
Land and damages, plus loss of productivity: (.05 + .00655) = .05655 x $2,257,000	128,000
	$ 293,000
Maintenance, operation and replacements	17,000
Total, annual charges (exclusive of preauthorization costs)	$ 310,000

The cost of a 4,100 acre-foot single-purpose water-conservation reservoir providing the same storage as does the proposed multiple-purpose reservoir was determined. The estimated first cost would be about $4,000,000, and the annual charges for interest and amortization and for annual maintenance, operation and replacement costs of $15,000 would be $218,000. Derivation of the annual cost is:

First cost:

Construction	$3,130,000	
Interest during construction (2 x 4% x ½)	125,000	
		$3,255,000
Land and damages	$ 870,000	
Interest during construction (2 x 4% x ½)	35,000	
		$ 905,000
Gross investment		$4,160,000

Annual charges:

Interest and amortization Construction (4% for 50 yrs.) (.04655 x $3,255,000)	$ 152,000
Lands and damages (.05 ≠ .0065) = .05655 x $905,000	51,000
	$ 203,000
Maintenance, operation and replacements	15,000
Total, annual charges (exclusive of preauthorization costs)	$ 218,000

C-36. The least costly alternative method of supplying water for urban and industrial use was found to be by obtaining the water from Hetch Hetchy system. The cost of this water has been found to be $70 per acre-foot and for economic purposes this cost is assumed to be the gross water conservation cost or benefit. To make a comparison with Hetch Hetchy cost it was necessary to make an estimate of the cost of treatment and conveyance of water from the proposed reservoir. These costs were found to be about $17 per acre-foot. This would leave a net cost of $53 per acre-foot for water developed at the proposed damsite. The 3,500 acre-feet of storage allocated for water conservation provides an estimated average annual yield of 1,500 acre-feet. The derivation of the water resources aspects are discussed in Appendix D.

C-37. ESTIMATED BENEFITS

The benefits credited to flood-control and water conservation as contained in the report and Appendix D, Water Conservation, and Appendix E, Flood Damage and Flood Control Benefits, are to be:

Flood control	$502,000
Water conservation (firm yield 1,500 acre-feet at $53 per acre-foot)	79,500
Total, average annual benefits	$581,500

The above benefits for water conservation were used as a basis for allocating costs.

C-38. ESTIMATE OF SEPARABLE COSTS

In order to determine the separable costs it is necessary to compute first, the annual charges for the multiple-purpose project. Because of differences in interest rates to be applied to Federal and non-Federal investments, the annual charges cannot be determined until the allocation of costs among purposes is known. This can be accomplished by trial and error methods, or by use of a formula developed in the San Francisco District. Annual charges for the multiple-purpose project as previously given are $377,000, exclusive of preauthorization surveys. Separable costs, therefore, are:

For flood control $377,000 -$79,500 = $297,500
for water conservation $377,000 -$310,000 = $ 67,000

C-39. ALLOCATION OF ANNUAL CHARGES

The following are the computations for deriving the allocation of annual costs among purposes:

Item	Flood control	Water conservation	Total
Separable cost	$297,500	$67,000	$364,500
Remaining to be distributed	-	-	12,500
Ratio of distribution	0.71[a]	0.29[a]	0.71
Distribution	8,500	4,000	12,500
Total, allocation	$306,000	$71,000	$377,000
Ratio to total annual charges	.811	.189	1.000

[a] Based on ratios of storage ($= \frac{8,500}{12,000} = 0.71$ and $\frac{3,500}{12,000} = 0.29$)

C-40. SUMMARY OF COST ALLOCATIONS

The allocations of first costs and annual charges, benefits and benefit-to-cost ratios, exclusive of the cost of the recreational facilities, are summarized below for ready reference:

Item	Flood control	Water conservation	Total
FIRST COST			
Ratio	0.834	0.166	1.000
Federal:			
Construction	$4,112,000	0	$4,112,000
Preauthorization surveys	63,000	$ 13,000	76,000
Total, Federal	$4,175,000	$ 13,000	$4,188,000
Non-Federal:			
Construction	None	$ 817,000	$ 817,000
Lands, easements, relocations	$2,354,000	471,000	2,825,000
Total, Non-Federal	$2,354,000	$1,288,000	$3,642,000
Total, first cost	$6,529,000	$1,301,000	$7,830,000
ANNUAL CHARGES			
Federal:			
Interest plus amortization	$ 155,000	$ 1,000	$ 156,000
Non-Federal:			
Interest plus amortization	$ 134,000	$ 67,000	$ 201,000
Maintenance and operation	19,000	4,000	23,000
Total, Non-Federal	$ 153,000	$ 71,000	$ 224,000
Total, annual charges	$ 308,000	$ 72,000	$ 380,000
Benefits	$ 502,000	$ 79,500	$ 581,500
B/C	1.6	1.1	1.5

C-41. METHOD OF FINANCING

Local interests are electing to repay the costs allocated to water conservation with interest at a rate to be established by the Secretary of the Treasury in 50 annual installments beginning with completion of the project. Land costs allocated to water conservation (see paragraph C-40, SUMMARY OF COST ALLOCATIONS) would be furnished by the Federal government. It is considered advisable for the Federal government to do all of the construction work, including relocation of utilities, and to purchase all lands, easements, and rights-of-way. Titles to all such lands would be transferred to local interests upon completion and acceptance of the project. Local interests would be required to contribute, in cash, prior to the start of construction, funds adequate to cover that part of the total cost of lands, easements, rights-of-way and relocations allocated to flood control which is 75.7 percent of the total cost of these items and is now estimated at $2,354,000. The funds required to be appropriated by the Federal government for constructing the project would be $6,035,000 as indicated below:

Feature	Amount	
Federal cost:		
Lands and damages	$ 2,570,000	
Relocations	215,000	
Reservoir	172,000	
Dam	3,969,000	
Access roads	41,000	
Engineering and design (including overhead)	415,000	
Supervision and administration	372,000	
Subtotal	$7,754,000	
Preauthorization surveys	76,000	
Subtotal	$7,830,000	
Basic public use recreational facilities		
Lands	285,000	
Construction	350,000	
Total, gross Federal cost	$8,465,000	
Less non-Federal cash contribution (0.834 x $2,825,000) =	2,354,000	
Net Federal cost	$6,111,000	
Less preauthorization surveys	76,000	
Federal funds required to be appropriated		$6,035,000

C-42. OTHER PLANS CONSIDERED

In addition to the reservoir studies, various channel improvements were considered as a possible solution to control flood runoff through the highly urbanized areas. Based on reconnaissance of the area and experience gained from works on similar streams in the San Francisco District, it was determined that widening and deepening the channel or providing protection by levees is not practicable because of excessive rights-of-way requirements, and would be more costly than bank-protective works. The most feasible plan of channel works was found to be a concrete-lined channel. Based on the storm of 1955 which had a discharge of 5,560 cubic-feet per second, a 5,000 cubic-foot per second capacity was selected as the lowest discharge for which improvements could be considered. A 7,000 cubic-foot per second capacity channel was also considered because it would adequately contain the discharge of record, and this discharge could be passed through the existing bridges with little or no modifications being required to the bridges. The standard project flood discharge of 13,800 cubic-feet per second was selected as the uppermost limit for which works should be designed.

C-43. The cost of improving the existing channel from the foothills, river mile 7.5, to Bayshore Freeway to a capacity of 5,000 cubic-feet per second would be in excess of the benefits resulting in a benefit-cost ratio of 0.4 to 1.0. The cost of improving the existing channel to 7,000 cubic-feet per second capacity would exceed the benefits resulting in a benefit-cost ratio of 0.8 to 1.0. The cost of improving the channel to provide protection equivalent to the standard project flood of 13,800 cubic-feet per second would result in a benefit-cost ratio of 0.6 to 1.0. Based on these findings, channel works were determined to be economically unjustified. Studies of channel works and reservoir affording the same benefits as a single-purpose flood-control reservoir revealed that the reservoir would be more feasible. This conclusion is based on the reservoir design flood hydrograph which shows that reservoir inflow in excess of 3,000 to 4,000 cubic-feet per second has about a one-day duration. If the reservoir release criteria are increased from 3,000 cubic-feet per second channel capacity basis to a 5,000 cubic-foot per second basis, it would mean that about 2,000 cubic-feet per second could be released during the period when the inflow exceeded outflow. Since this period is equal to about one day, then the flood-control storage of 9,100 acre-feet could be decreased by 4,000 acre-feet resulting in 5,100 acre-feet of storage being required. The annual cost for a 5,100 acre-foot flood-control reservoir would be $245,000, and the annual cost of a 5,000 cubic-foot per second channel from Pope Street to Bayshore Freeway would be $155,000 for a total of $400,000 compared to a $310,000 annual cost of a 9,100 acre-foot flood-control reservoir. Also, a combined project would be less desirable than the proposed multipurpose reservoir because of more interference with existing developments and facilities, and because the aesthetic value of the creek would be destroyed. Therefore, based on the above analyses, it was determined that the most feasible plan for flood control including water conservation for San Francisquito Creek is the proposed multiple-purpose project.

REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK,
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX D

WATER RESOURCES DEVELOPMENT

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REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX D

WATER RESOURCES DEVELOPMENT

GENERAL

D-1. SCOPE

This appendix presents an analysis of the water resources potential of the San Francisquito Creek Basin, California. It includes analyses of existing and possible alternate water supplies, runoff, and water requirements, development of future water requirements, determination of capacity which could be made available for water conservation, yield from the adopted water conservation storage of 3,500 acre-feet, and estimation of the benefits expected to accrue from construction and operation of the proposed water conservation feature.

WATER SUPPLY

D-2. DRAINAGE AREAS

The principal drainage area pertaining to a study of water resources in the San Francisquito Creek Basin for the proposed damsite is 28.0 square miles. The site is approximately two miles downstream from the existing Searsville Reservoir near Palo Alto, California.

D-3. RUNOFF

A tabulation of gaging stations for the San Francisquito Creek drainage basin is given in Appendix A. The runoff data collected from the gaging stations as published in Water supply papers were studied and the natural monthly runoff was found as follows:

a. For water years, 1916 to 1919, by correlation with Crystal Springs Reservoir on the basis of the drainage areas.

b. From water years, 1920 to 1931, by monthly correlation between runoff and precipitation for the base period water year 1892 to 1919 at the Rixford precipitation station.

c. From water years, 1931 to 1941, the summation of the flows of San Francisquito Creek at Stanford plus Lagunita Canal at Stanford, plus Searsville draft and evaporation, plus diversion by California Water Service Company, minus Los Trancos Creek at Stanford.

d. From water years, 1941 to 1956, by monthly correlation with Upper Bear Gulch Creek using the base period water years, 1931 to 1941.

The derived natural monthly runoff for the period of water years, 1916 through 1956, is given in Table I. The estimated annual natural runoff is presented on Plate D-1. The driest year was 1924 with an estimated total flow of 1,200 acre-feet. The wettest year was 1952 with an estimated total flow of 31,100 acre-feet. The estimated annual natural runoff based on a 41-year average was 12,300 acre-feet.

D-4. RUNOFF AVAILABLE FOR STORAGE

The actual flow past the damsite under existing conditions is less than the natural streamflow due to the Searsville Reservoir upstream of the proposed damsite and diversion by the California Water Service Company from Bear Gulch Creek. By use of the California Water Service Company records of diversions of Bear Gulch Creek and by estimating consumption and evaporation from Searsville Reservoir, the runoff at the proposed damsite was computed as follows:

a.	Natural flow at damsite (annual average for 41-year period)	12,300 acre-feet
b.	Consumption and evaporation from Searsville (estimated average annual)	-600 " "
c.	Diversion by California Water Service Company (average annual)	-1,300 " "
d.	Average annual flow past damsite (existing conditions)	10,400 " "
e.	Percent, existing conditions, to total natural flow	$\frac{10{,}400}{12{,}300} \times 100 = 85\%$

The estimated runoff past the damsite, therefore, was taken as 85 percent of the natural runoff at the site. The resulting values are shown in Table II and on Plate D-1.

D-5. WATER RIGHTS

No definite data are available on percolation below the damsite. The only water rights filed on San Francisquito water are those of the California Water Service Company. However, Stanford University and other property owners in the area may have some riparian claim to water from the creek. The amount of water claimed is probably small and the influence of water reserved by rights other than those filed also may be small. **However, for purposes of this study, a flow of 3 c.f.s., or approximately 200 acre-feet per month, was assumed as the requirement to** meet downstream percolation and other incidental uses.

D-6. EXISTING SOURCES OF WATER SUPPLY

The city of Palo Alto has three independent water supply sources. They are: (a) ground water from city-owned wells; (b) Hetch Hetchy water from a separate 36-inch line (Palo Alto pipeline) of the San Francisco Water Department; and (c) Hetch Hetchy water from a separate 72-inch line (Bay Line No. 3) of the San Francisco Water Department. The quantity of water available from the Hetch Hetchy system is believed to be in excess of Palo Alto's future demands. Actual yield from the city-owned wells is approximately 6,000 acre-feet each year. Since recharging of the ground basin appears uncertain, it is doubtful if future annual yields from the wells will exceed the present 6,000 acre-feet.

D-7. As indicated above, the city-owned wells are being fully utilized and supplemental water is being purchased under contract with the San Francisco Water Department. The cost of the water varies from a maximum of about $133 per acre-foot for small amounts to a minimum of about $70 per acre-foot beyond a certain amount. Since the average cost to Palo Alto in 1955-56 was $74 per acre-foot (2,716 acre-feet at $201,100), the major portion of the water purchased is, by far, in the $70 per acre-foot cost range. For purposes of this report, therefore, the cost of $70 per acre-foot was used as the least alternate cost of water.

D-8. FIRM YIELD

Firm yield may be defined as the maximum dependable sustained rate of draft from a reservoir that could be maintained through a critically deficient water-supply period. Routings were made based on the monthly runoff values given in Table II, and considered the uncontrolled outflow of flood waters. Mandatory releases to meet possible existing uses and percolation requirements downstream from the damsite were assumed to be 200 acre-feet per month as mentioned under WATER RIGHTS. Evaporation losses were based on an estimated annual net evaporation rate of four feet and adjusted for monthly amounts. Computations were made for several assumed firm yield values. The curve of firm yield versus conservation storage, as derived from this analysis, is shown on Plate D-2. The ultimate firm yield from this reservoir was approximately 5,500 acre-feet. The following tabulation gives an indication of the spill-to-spill periods involved in obtaining various yields.

Yield (thousands of acre-feet)	Conservation storage (thousands of acre-feet)	Critical period (years)	Spill-to-spill period (years)
1.1	2.5	2	2
4.0	10.0	3	4
4.9	14.0	12	14
5.5	30.0	12	15

The tabulation indicates an abrupt change in the critical period between the yields of 4,000 and 4,900 acre-feet. This is estimated to take place at a yield of about 4,200 acre-feet. A spill-to-spill period of more than seven years is considered too great for this size of reservoir because previous studies have shown the cost tends to be excessive.

D-9. The capacity of the proposed reservoir on San Francisquito Creek is limited by topographic and other conditions to 12,600 acre-feet. Of this total 3,500 acre-feet has been allocated to water conservation, and the remainder being required for flood control and siltation. The annual firm yield resulting from 3,500 acre-feet of storage was determined to be 1,500 acre-feet, and was used in the economic evaluation of conservation benefits.

D-10. POPULATION STUDIES

Population projections for the city of Palo Alto were used as the basis for determining future water requirements. The projections were, in turn, based on population forecasts for the general area prepared by the U. S. Department of Commerce and information supplied by the city of Palo Alto. Based on this information the following table and Plate D-3 were derived showing the expected rate of growth for Palo Alto during the next 60 years:

Estimated Population, City of Palo Alto, 1960-2020

Year	High	Maximum
1960	51,100	51,100
1970	68,000	68,000
1980	72,000	76,500
1990	74,000	84,200
2000	78,000	87,800
2010	82,000	92,300
2020	84,400	95,000

D-11. Both sets of forecasts assume that the economy will be at a sustained high level throughout the projection period, and that the city of Palo Alto will continue to annex adjacent unincorporated lands (as it has done in recent years). Based on the single set of Department of Commerce projections for the general area, the differences between the high and maximum forecasts are the results of alternate estimates as to the proportion of successive area increases that will occur in the physically expanding city of Palo Alto.

D-12. Between 1950 and 1960, the population of the city of Palo Alto increased from 25,300 to 52,000. However, the population in the water service area within the city of Palo Alto, and a 2.5 square mile unincorporated area adjacent to the west boundary of Stanford University campus, will probably increase from 52,000 to about 68,000 between 1960 and 1970 and, by the year 2020, should be more than 95,000.

D-13. WATER REQUIREMENTS

The high estimate of population of 84,400 for year 2020 was used in determining the water requirements for Palo Alto. A unit-use of water (in acre-feet per year per capita) was taken from the Palo Alto report varying from 0.185 in 1956 to 0.350 for year 2020. Plate D-4 is a curve of water requirements versus time in years, and was obtained as the product of population estimated and the corresponding unit-use of water for a given year. The supplemental requirements may be fulfilled in part by development of local sources of supply, or by import from sources outside the basin. Such a source is the Hetch Hetchy supply. However, local spokesmen have indicated their interest in developing local sources of supply if such development is cheaper than Hetch Hetchy water.

D-14. ALTERNATE SOURCES OF SUPPLY

The State Department of Water Resources, in its study of the California Water Plan, considers the importation of water from both the Feather River Project and the Delta Region of the Sacramento-San Joaquin Rivers to terminal reservoirs serving areas having a water shortage. The State Water Plan envisions the development of a million or more acre-feet of water for use throughout the State. The cost of bringing into the San Francisquito Creek basin a limited supply of water from outside sources, other than the presently developed Hetch Hetchy system, is not feasible at this time. However, the State of California in its development of the South Bay Aqueduct, a part of its water plan, may find it practicable to supply supplemental water to the Palo Alto area. When the State's cost for this water has been determined, consideration will be given to its feasibility. At present the only potential source of water other than Hetch Hetchy is from San Francisquito Creek itself.

D-15. WATER QUALITY

The California Water Service Company diverts water from Bear Gulch Creek, a tributary of San Francisquito Creek, and clarifies it in a settling reservoir. The area above the diversion points is a company-owned, well-protected watershed. Bear Gulch water is treated in the reservoir with copper sulphate to control algae growth. Other water treatments include screen and cloth filtering, aeration chlorination, and ammonia additives (the State Department of Public Health will establish the requirements for water quality for the proposed San Francisquito Creek reservoir).

D-16. WATER TREATMENT AND CONVEYANCE

Assuming that water from San Francisquito Creek would require treatment, a rapid sand filter would be required to remove the turbidity and improve water quality. It is estimated that a rapid sand filter of a million-gallon-day capacity would cost approximately $100,000, and would have a 30-year life based on the experience of local water service companies in the area. The annual cost factor of 3-1/2 percent for 30 years of life, plus .063 for operation and maintenance, equals 0.12. For the proposed conservation storage of 3,500 acre-feet with a firm yield annually of 1,500 acre-feet, the design capacity of the filter plant would be 140 acre-feet per month, or 1.5 m.g.d. This would require a capital cost of $150,000, or an annual cost of $17,600. A pipeline would be required to deliver the water from the reservoir to the Palo Alto distribution system. The pipeline required for this purpose would be a ten-inch diameter welded steel pipe 18,000 feet long. The cost for this pipeline is estimated at $180,000. The annual cost factor for 3-1/2 percent with 50 years of life, plus .003 for operation and maintenance, equals 0.046. Therefore, the annual cost of the conveyance will be $8,200. Total annual cost for treatment and conveyance equals $17,600 plus $8,200, for a total of $25,800. The cost per acre-foot equals $17.20 which has been rounded to $17 per acre-foot for use in this report.

D-17. CONSERVATION BENEFITS

The water made available from the conservation pool firm yield could be used for domestic purposes. Domestic and industrial water supply benefits are measured by the cost of providing the most economical alternative means of obtaining the needed water. To determine the benefits from conservation, several alternate sources were investigated including the potential of a single-purpose (water conservation) reservoir. As given in Appendix C, the estimated first cost of such a reservoir is estimated to be slightly in excess of $4,000,000, and annual charges including maintenance and operation, in excess of $200,000. The cost of water would exceed $125 per acre-foot for the estimated 1,500 acre-foot firm yield. The least cost of an alternate supply was found to be from the existing Hetch Hetchy system of the San Francisco Water Department. As developed previously, the cost of this water is $70 per acre-foot. The cost of treatment and conveyance of any water developed from San Francisquito Creek would be about $17 an acre-foot. This would leave a net benefit of $53 per acre-foot for water developed at the damsite. For cost benefit comparisons, $53 an acre-foot is the benefit used for water developed from the proposed San Francisquito Creek reservoir.

D-18. The total conservation benefit based on the firm yield of 1,500 acre-feet per year is $79,500.

TABLE I

San Francisquito Creek Basin
Estimated Natural Monthly Runoff at the San Francisquito Creek Damsite
(thousands of acre-feet)

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
1916	0	.3	1.8	18.8	5.5	2.7	.5	.2	0	0	0	0	29.8
1917	.5	.2	1.5	1.0	5.6	1.4	.5	.2	.2	0	0	0	11.1
1918	0	.2	.4	0	.8	1.0	.1	0	0	0	0	.8	3.3
1919	.5	.2	.1	.6	3.9	5.0	1.0	.4	0	0	0	0	11.7
1920	0	0	.3	.1	.2	1.6	.9	.4	0	0	0	0	3.5
1921	.2	.4	2.2	6.6	2.7	1.2	.5	.2	0	0	0	0	14.0
1922	0	0	1.3	1.1	3.4	1.3	.2	0	0	0	0	0	7.3
1923	.1	.5	4.6	1.4	.6	1.6	.5	.2	0	0	0	0	9.5
1924	0	0	0	.1	.2	.3	.5	.1	0	0	0	0	1.2
1925	0	0	.3	.4	3.0	1.1	.8	1.8	.2	0	0	0	7.6
1926	0	0	.1	.8	3.6	.4	1.4	.2	0	0	0	0	6.5
1927	0	1.5	1.6	2.0	3.6	1.2	2.1	.4	.1	0	0	0	12.5
1928	0	.2	.5	.6	1.6	2.0	1.4	.5	.1	0	0	0	6.9
1929	0	.2	.4	.2	1.0	.5	.3	.1	0	0	0	0	2.7
1930	0	0	.2	3.0	2.2	1.2	.4	.1	0	0	0	0	7.1
1931	0	.2	.1	1.5	.5	.3	.1	.1	0	0	0	0	2.8
1932	.1	0	4.4	2.4	4.2	.4	.2	.1	.1	0	0	0	11.9
1933	0	.1	.1	2.1	.3	.9	.3	.2	.1	0	0	0	4.1
1934	0	0	.2	.4	1.0	.4	.1	0	0	0	0	0	2.1
1935	0	0	0	3.3	.3	2.2	4.0	.3	.1	0	0	0	10.2
1936	0	0	.1	1.6	8.9	1.1	.8	.2	.1	0	0	0	12.8
1937	0	0	.1	1.3	6.8	8.1	1.8	.5	.2	0	0	0	18.8
1938	0	.1	2.6	1.8	12.2	10.6	2.2	.6	.2	.1	0	0	30.4
1939	0	.1	.1	.3	1.2	.8	.1	0	0	0	0	0	2.6

TABLE I (continued)

San Francisquito Creek Basin
Estimated Natural Monthly Runoff at the San Francisquito Creek Damsite
(thousands of acre-feet)

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep	Total
1940	0	0	0	4.2	9.3	6.1	1.8	.5	.2	.1	0	0	22.2
1941	0	0	1.2	5.3	8.7	4.4	5.9	1.1	.4	.1	0	.1	27.2
1942	.1	0	1.4	6.9	9.4	2.9	1.7	.6	.4	.1	0	0	23.5
1943	.1	.6	1.3	9.5	6.1	2.8	1.0	.6	.3	.1	0	.1	22.5
1944	.1	.1	.1	1.0	6.0	1.6	.3	.2	.3	.1	0	0	9.8
1945	0	.5	1.0	1.0	4.0	4.9	.8	.5	.3	0	0	0	13.0
1946	0	.1	2.1	3.5	1.6	1.4	.7	.5	.2	.1	0	0	10.2
1947	0	.1	.6	.2	.3	1.8	.3	.3	0	0	0	0	3.6
1948	.2	.1	.1	.5	.1	1.4	1.2	.5	.2	0	0	0	4.3
1949	0	0	.6	1.1	6.9	4.8	.7	.5	.4	0	0	0	15.0
1950	0	0	.1	4.5	3.8	1.7	1.2	.6	.4	0	0	0	12.3
1951	.1	.6	3.4	5.2	6.0	6.4	1.2	.8	.4	.2	.1	.1	24.5
1952	0	0	3.0	11.0	7.9	6.1	1.4	.8	.5	.2	.1	.1	31.1
1953	0	0	.3	4.7	2.8	2.0	1.2	.8	.6	.2	.1	.1	12.8
1954	.1	.1	.6	1.6	.8	2.0	.5	.4	.3	0	0	0	6.4
1955	0	.1	1.0	1.0	1.6	1.5	.7	.6	.3	.1	0	0	6.9
1956	0	0	2.0	12.0	8.1	5.4	.1	.2	0	0	0	0	27.8
Total 41 yrs.	2.1	6.5	41.8	124.6	156.7	104.5	41.4	16.3	6.6	1.4	.3	.3	503.5
Average 41 yrs.	.1	.2	1.0	3.0	3.8	2.6	1.0	.4	.2	.0	.0	.0	12.3

TABLE II

Estimated Adjusted Runoff at the San Francisquito Creek Damsite
(Computed as 85 percent Estimated Natural Monthly Runoff)
(thousands of acre-feet)

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Total
1916	0	0.3	1.5	16.0	4.7	2.3	0.4	0.2	0	0	0	0	25.4
1917	0.4	0.2	1.3	0.8	4.8	1.2	0.4	0.2	0.2	0	0	0	9.5
1918	0	0.2	0.3	0	0.7	0.8	0.1	0	0	0	0	0.7	2.8
1919	0.4	0.2	0.1	0.5	3.3	4.2	0.8	0.3	0	0	0	0	9.8
1920	0	0	0.3	0.1	0.2	1.4	0.8	0.3	0	0	0	0	3.1
1921	0.2	0.3	1.9	5.6	2.3	1.0	0.4	0.2	0	0	0	0	11.9
1922	0	0	1.1	0.9	2.9	1.1	0.2	0	0	0	0	0	6.2
1923	0.1	0.4	3.9	1.2	0.5	1.4	0.4	0.2	0	0	0	0	8.1
1924	0	0	0	0.1	0.2	0.3	0.4	0.1	0	0	0	0	1.1
1925	0	0	0.3	0.3	2.6	0.9	0.7	1.5	0.2	0	0	0	6.5
1926	0	0	0.1	0.7	3.1	0.3	1.2	0.2	0	0	0	0	5.6
1927	0	1.3	1.4	1.7	3.1	1.0	1.8	0.3	0.1	0	0	0	10.7
1928	0	0.2	0.4	0.5	1.4	1.7	1.2	0.4	0.1	0	0	0	5.9
1929	0	0.2	0.3	0.2	0.8	0.4	0.3	0.1	0	0	0	0	2.3
1930	0	0	0.2	2.5	1.9	1.0	0.3	0.1	0	0	0	0	6.0
1931	0	0.2	0.1	1.3	0.4	0.3	0.1	0.1	0	0	0	0	2.5
1932	0.1	0	3.7	2.0	3.6	0.3	0.2	0.1	0.1	0	0	0	10.1
1933	0	0.1	0.1	1.8	0.3	0.8	0.3	0.2	0.1	0	0	0	3.7
1934	0	0	0.2	0.3	0.8	0.3	0.1	0.	0	0	0	0	1.7
1935	0	0	0	2.8	0.3	1.9	3.4	0.3	0.1	0	0	0	8.8
1936	0	0	0.1	1.4	7.6	0.9	0.7	0.2	0.1	0	0	0	11.0
1937	0	0	0.1	1.1	5.8	6.9	1.5	0.4	0.2	0	0	0	16.0
1938	0	0.1	2.2	1.5	10.4	9.0	1.9	0.5	0.2	0.1	0	0	25.9
1939	0	0.1	0.1	0.3	1.0	0.7	0.1	0	0	0	0	0	2.3

TABLE II (continued)

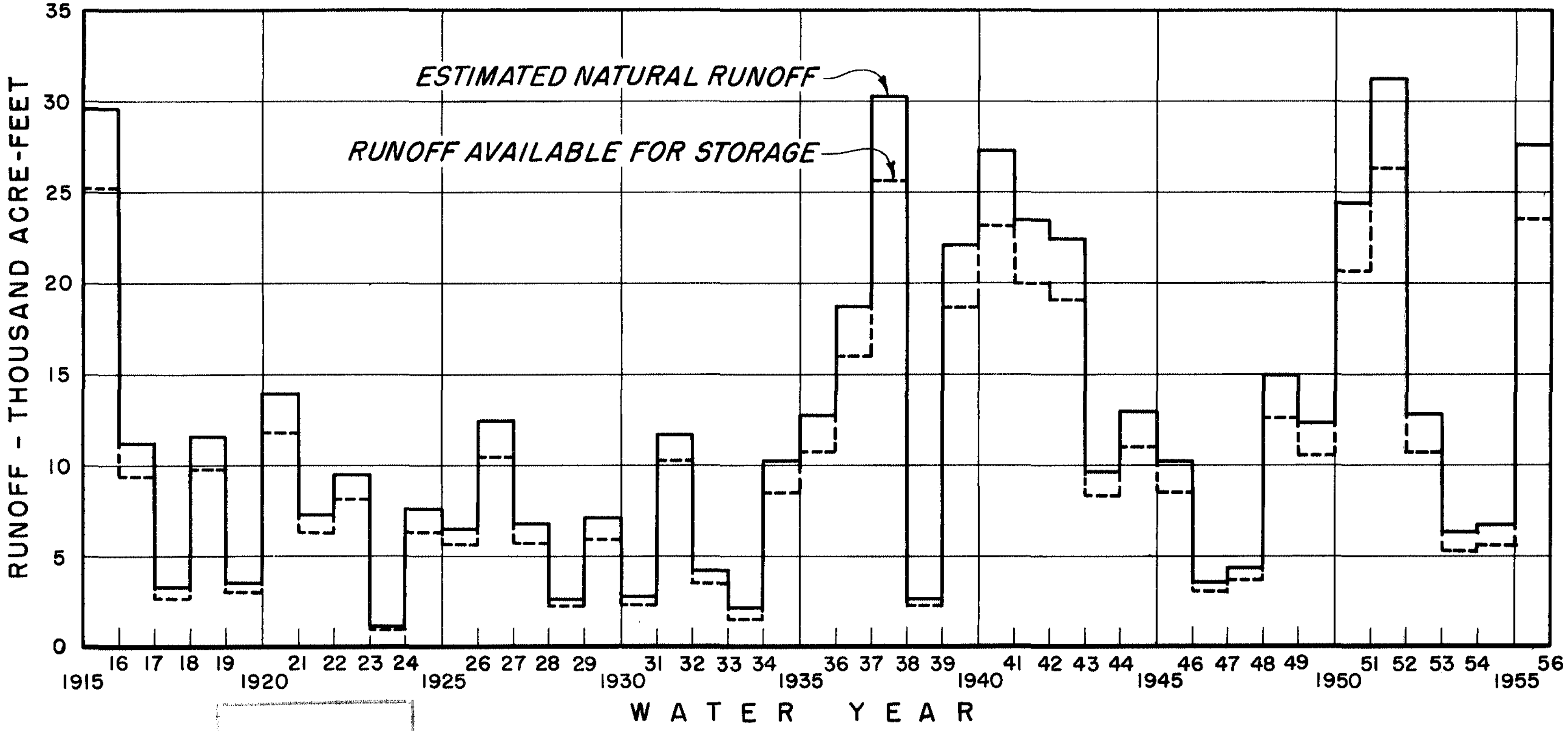
Estimated Adjusted Runoff at the San Francisquito Creek Damsite

(Computed as 85 percent Estimated Natural Monthly Runoff)
(thousands of acre-feet)

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Total
1940	0	0	0	3.6	7.9	5.2	1.5	0.4	0.2	0.1	0	0	18.9
1941	0	0	1.0	4.5	7.4	3.7	5.0	0.9	0.3	0.1	0	0.1	23.0
1942	0.1	0	1.2	5.9	8.0	2.5	1.4	0.5	0.3	0.1	0	0	20.0
1943	0.1	0.5	1.1	8.1	5.2	2.4	0.8	0.5	0.3	0.1	0	0.1	19.2
1944	0.1	0.1	0.1	0.8	5.1	1.4	0.3	0.2	0.3	0.1	0	0	8.5
1945	0	0.4	0.8	0.8	3.4	4.2	0.7	0.4	0.3	0	0	0	11.0
1946	0	0.1	1.8	3.0	1.4	1.2	0.6	0.4	0.2	0.1	0	0	8.8
1947	0	0.1	0.5	0.2	0.3	1.5	0.3	0.3	0	0	0	0	3.2
1948	0.2	0.1	0.1	0.4	0.1	1.2	1.0	0.4	0.2	0	0	0	3.7
1949	0	0	0.5	0.9	5.9	4.1	0.6	0.4	0.3	0	0	0	12.7
1950	0	0	0.1	3.8	3.2	1.4	1.0	0.5	0.3	0	0	0	10.3
1951	0.1	0.5	2.9	4.4	5.1	5.4	1.0	0.7	0.3	0.2	0.1	0.1	20.8
1952	0	0	2.6	9.4	6.7	5.2	1.2	0.7	0.4	0.2	0.1	0.1	26.6
1953	0	0	0.3	4.0	2.4	1.7	1.0	0.7	0.5	0.2	0.1	0.1	11.0
1954	0.1	0.1	0.5	1.4	0.7	1.7	0.4	0.3	0.3	0	0	0	5.5
1955	0	0.1	0.8	0.8	1.4	1.3	0.6	0.5	0.3	0.1	0	0	5.9
1956	0	0	1.7	10.2	6.9	4.6	0.1	0.2	0	0	0	0	23.7
Total 41 yrs.	1.9	5.8	35.7	105.8	133.8	88.8	35.2	13.9	5.9	1.4	0.3	1.2	4429.7
Average 41 yrs	0	0.1	0.9	2.6	3.3	2.2	0.9	0.3	0.1	0	0	0	10.5

CORPS OF ENGINEERS

U.S. ARMY



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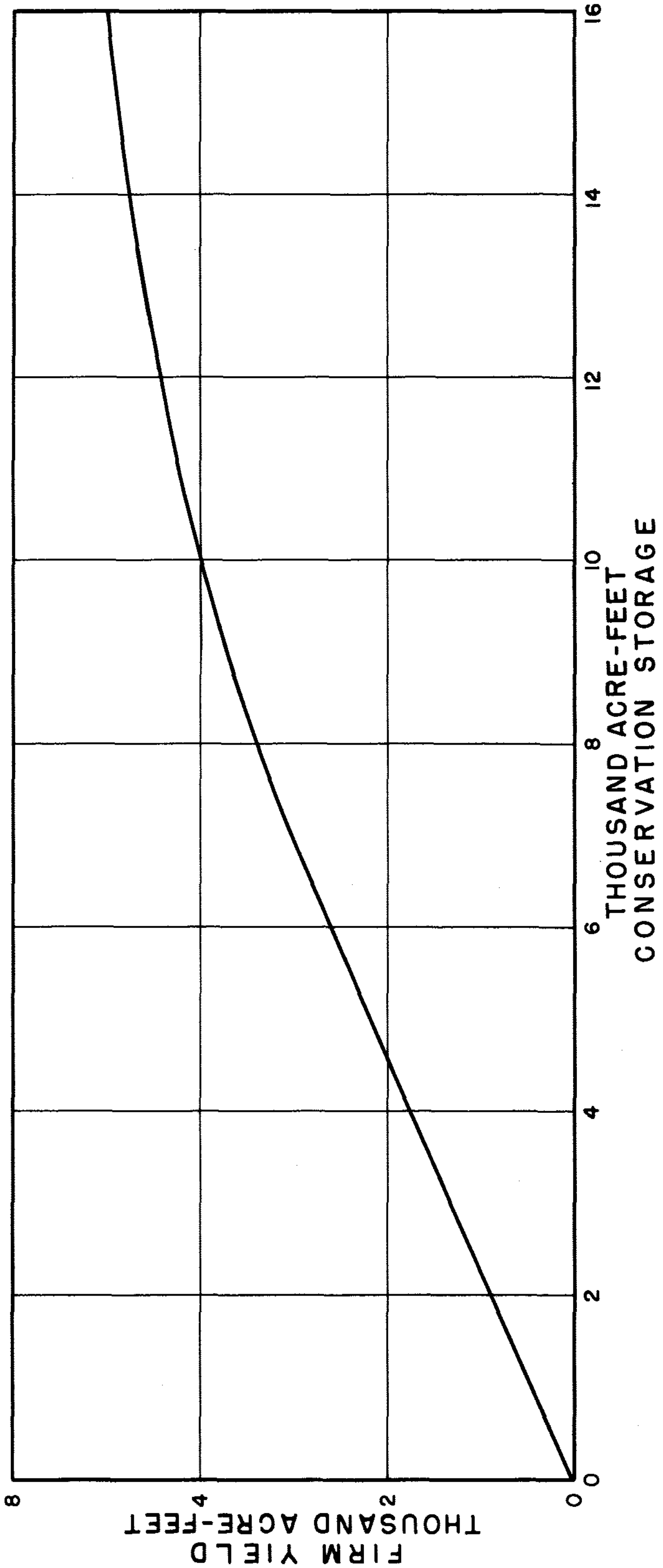
FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
WATER RESOURCES

RUNOFF DIAGRAM

IN 4 SHEETS SHEET NO. 1
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C. OF E.
DRAWN: B.C.J. FILE NO.
TRACED: R.W.S. TO ACCOMPANY REPORT 72-32-1
CHECKED: M.A.B. DATED: JAN. 1961

PLATE D-1



FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
WATER RESOURCES

FIRM YIELD VS. CONSERVATION STORAGE

IN 4 SHEETS SHEET NO. 2
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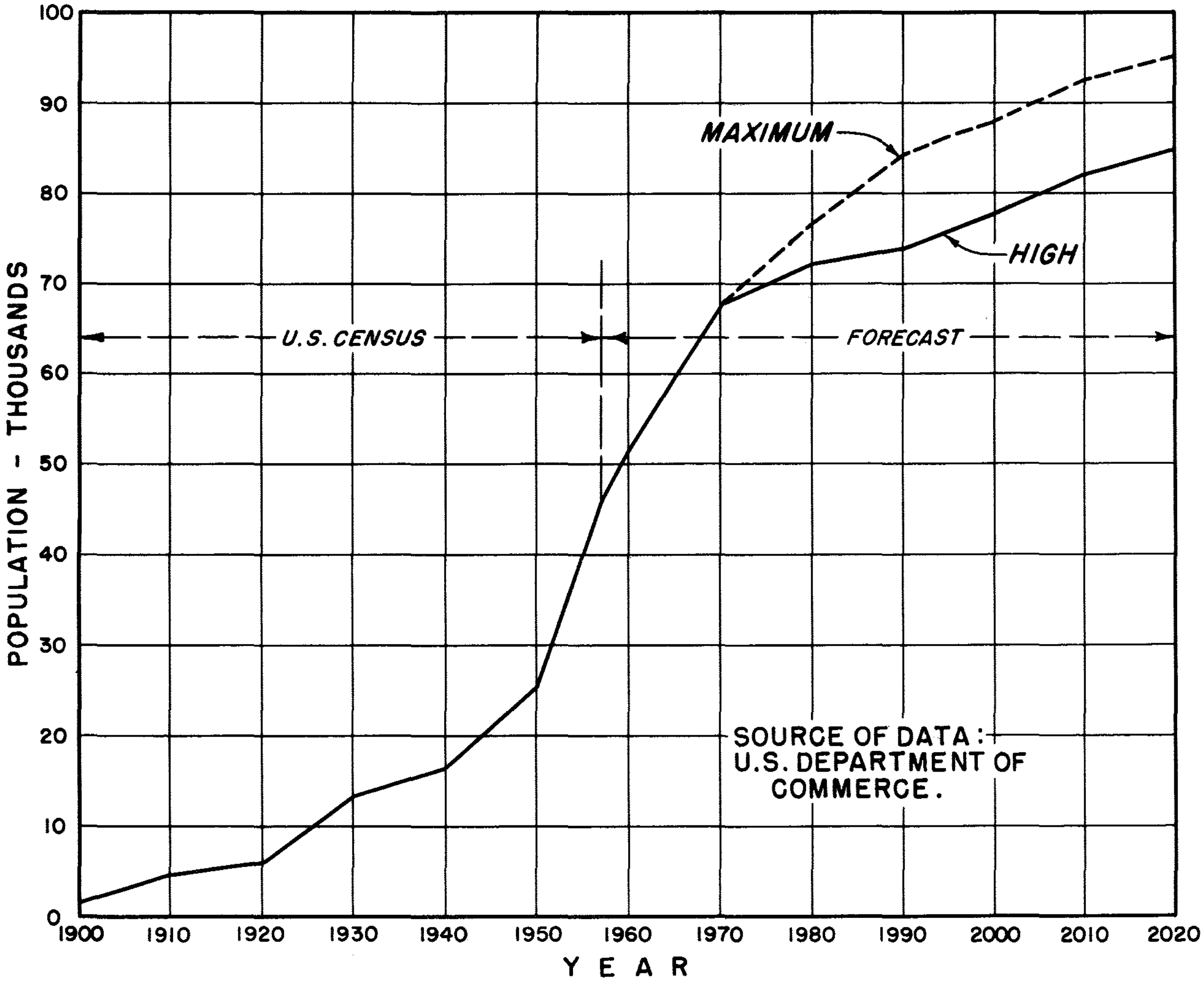
CHECKED: M.A.B. DATED: JAN. 1961



FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
WATER RESOURCES

PALO ALTO, CALIF., PAST & PREDICTED POPULATION

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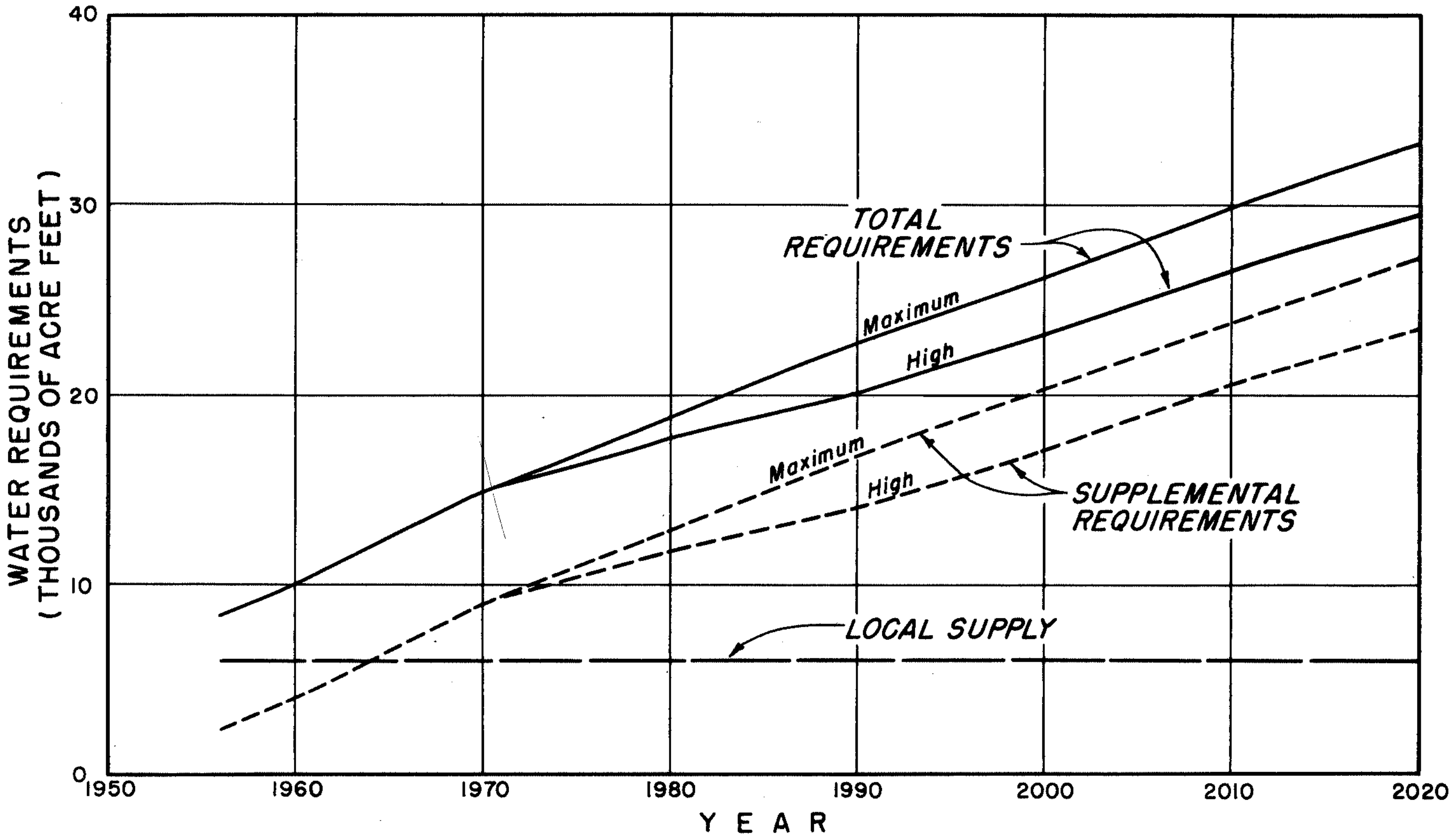
CHECKED: M.A.B. DATED: JAN. 1961



NOTES:

1. TOTAL WATER REQUIREMENTS BASED ON U.S. DEPARTMENT OF COMMERCE GENERAL AREA POPULATION FORECASTS AND UNIT-USE ESTIMATES BASED ON THE PALO ALTO REPORT.
2. LOCAL SUPPLY IS THE ESTIMATED SAFE YIELD FROM THE CITY WELLS.
3. SUPPLEMENTAL REQUIREMENTS IS THE DIFFERENCE BETWEEN TOTAL REQUIREMENTS AND LOCAL SUPPLY.

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
WATER RESOURCES

ESTIMATED WATER REQUIREMENTS - PALO ALTO

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PLATE D-4

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REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK,
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX E

FLOOD DAMAGE AND FLOOD-CONTROL BENEFITS

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REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK, SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX E

FLOOD DAMAGE AND FLOOD-CONTROL BENEFITS

GENERAL

E-1. SCOPE

This appendix contains a description of the general methods of the derivation of extent, type, and monetary evaluation of flood damage resulting from specific floods, and evaluation of damage that would be expected from a flood of the magnitude of a standard project flood, correlation of damage with flood discharge, derivation of average annual damage, and estimates of benefits that might be expected to accrue from construction of proposed flood-control works, as described in the main report.

FLOOD DAMAGES

E-2. GENERAL

The historical overflow of San Francisquito Creek begins at Middlefield Road in Palo Alto and flows southeasterly through Palo Alto to and along Bayshore Freeway. East of the freeway the area is generally flooded to the tidal levees along San Francisco Bay. Flood flows southward along the west side of the freeway to Matadero Creek and during high discharges, the flood plains of San Francisquito Creek and Matadero Creek overlap. As a consequence, flood flows from San Francisquito Creek are impounded until flow in Matadero Creek recedes. Since normal storm drainage in this area is discharged into Matadero Creek, and the area could be flooded from Matadero Creek alone, damages from San Francisquito Creek were estimated only for the area north of Colorado Avenue. Previous to 1942, the area inundated was devoted primarily to agriculture with little or no residential or commercial developments. Since 1942, the area west of Bayshore Freeway Bypass has been almost completely urbanized with subdivisions and attendant commercial establishments. The area east of the highway has been developed by construction of an airport, a golf course, a tranocean radio and telegraph transmitter station, the Palo Alto Sewage Treatment Plant, and a yacht harbor. It has been estimated that a discharge with the magnitude of the standard project flood would overtop the creek banks in the vicinity of river mile 6.5 downstream from Oak Knoll School and flood both sides of the stream inundating large portions of Menlo Park, Palo

Alto and East Palo Alto, downstream to the tidal levees along San Francisco Bay. Due to the porous nature of the creek banks, erosion and scouring are a continuing source of damage during flood flows. Channel capacities based on existing average conditions were adopted as the basis for analysis of damage data. The extent of inundation is best reflected by peak stages reached by a flood which can be correlated with discharge. The December 1955 and standard project flood plains are shown on Plate E-1.

E-3. TYPES AND EXTENT OF IMPROVEMENTS IN THE FLOOD PLAIN

The flood plain of San Francisquito Creek is devoted primarily to urban development with attendant commercial endeavors. The main railroad line of the Southern Pacific Company between San Francisco and Los Angeles traverses the flood plain. The Southern Pacific Company, in addition to its main line to Los Angeles, provides a major portion of the daily urban passenger service between peninsular points and San Francisco. Bayshore Freeway and El Camino Real (Highway U.S. 101) traverse the flood plain and form the major highway system for the large daily traffic between San Francisco and peninsular points. Numerous county roads and city streets cross the flood plain. Due to almost full urbanization of the area in recent years, agricultural endeavors in the flood plain have been reduced to the growing of nursery stock and flowers.

E-4. VALUE AND PRODUCTIVITY OF THE FLOOD PLAIN

On the basis of 1958 prices, the value of land and improvements in the standard project flood plain is estimated to be $275,000,000. This estimate is for residential and commercial properties. Values of highways, city streets, railroads and public utilities have not been estimated.

E-5. EXISTING IMPROVEMENTS

There are no existing Corps of Engineers' improvements in the San Francisquito Creek basin. At the request of local interests, however, Federal funds in the amount of approximately $200,000 were expended by the Corps of Engineers for emergency channel clearing, levee restoration and emergency bank protection along San Francisquito Creek in 1955 and 1956. Local interests have constructed various types of bank-protection works at intermittent points. These include concrete and timber walls, wire and poles, riprap using rock and scrap material, and sacked concrete revetment. Records of costs of these works and time of construction are practically non-existent. The value of these works has been estimated to be about $415,000 under October 1959 prices.

E-6. FEBRUARY 1940 FLOOD

A discharge of 3,100 cubic feet per second from San Francisquito Creek caused flooding in February 1940 of the Agricultural area upstream from Bayshore Freeway and of the area below the highway to the tidal levees. Inundation was caused by a levee break some 300 feet upstream from Bayshore Freeway, and damage was comparatively light when compared to the damage that would now occur in this highly urbanized area under a similar flood discharge.

E-7. DECEMBER 1955 FLOOD

Shortly after 6:00 p.m. on 22 December 1955, a heavy tropical-type storm accompanied by near hurricane winds and torrential rainfall, struck the entire watershed area of the streams that flow through Palo Alto. The water in San Francisquito Creek rose rapidly after 7:00 p.m., and by 9:45 p.m. was approximately one foot below the highway pavement at Bayshore Freeway. During the high flows of the early evening, a log jam developed at Bayshore Freeway which caused the stream to overflow the south bank above the freeway. This water flowed south, parallel to the freeway through city streets, thence into a new subdivision where the water reached a maximum depth of more than three feet above the floors of many homes. Upstream at the Pope-Chaucer Street bridge, another log jam developed at approximately the same time causing water to overflow the right bank at this point and flow into the city of Palo Alto. The still rising stream overflowed in a leveed section some 400 feet upstream from Bayshore Freeway shortly after midnight on 23 December. Overflow also occurred in an unleveed section approximately 2,000 feet upstream from Bayshore Freeway. Peak overflow was observed at approximately 1:30 a.m., 23 December, at which time the creek overflowed at Middlefield Road and for approximately one mile downstream through city streets and residential yards. This overflow was maintained for approximately an hour, after which the stream began to fall gradually and had returned to its banks by 4:00 a.m. During the period 11:30 p.m., 22 December to 3:30 a.m., 23 December, floodwater flowing over Bayshore Freeway was approximately ten inches deep near San Francisquito Creek, and about three inches deep near Matadero Creek to the south. Downstream from Bayshore Freeway, the overflow water covered portions of a golf course and subsequently moved into an airport area. The peak discharge recorded at midnight, 22 December 1955, was 5,560 cubic feet per second from a drainage area of 37.5 square miles above the Stanford University gaging station. This flood, the maximum of record, caused extensive damage to homes and their contents, and to commercial enterprises and their products. Bank erosion to residential property occurred due to continued high flows. The Bayshore Freeway was closed to traffic several hours causing rerouting of traffic.

E-8. APRIL 1958 FLOOD

Flooding from San Francisquito Creek in April 1958 occurred in the reaches between Newell Road (mile 2.2) and Bayshore Freeway (mile 1.5) and below Bayshore Freeway due to a levee failure at about (mile 1) on the right bank. During the high flows, debris collected on the upstream side of the Bayshore Freeway bridge. In conjunction with the debris collection, the poor entrance characteristics of the Bayshore

Freeway bridge created a 3- to 4-foot difference in water surface between the upstream and downstream sides which caused the creek to overflow the north bank above the freeway and flow over the freeway at the bridge. Bank erosion caused considerable damage. Water surface during the peak discharge reached top of the freeboard of the levees on the south bank. If these levees had been overtopped or failed, a highly developed area of the city of Palo Alto would have been inundated causing extensive damage to homes and their contents. As the result of the overflow of Bayshore Freeway, the area between the freeway and the creek was inundated to a depth of two to three feet prior to the levee break at mile 1. The levee break caused inundation of additional areas downstream from the freeway including the Palo Alto Airport and Golf Course. Water inundated these areas to depths of three to four feet and it was necessary to remove the water by pumping. The peak discharge recorded was 4,460 cubic feet per second.

E-9. FLOOD DAMAGE SURVEYS

Flood damage data previous to the December 1955 flood are incomplete. Records of damages from floods that occurred in 1894, 1895 and 1909 are non-existent. During the past 50 years, overbank flows are known to have occurred in 1911, 1916, 1919, 1940, 1943, 1950, 1955 and 1958. Development in the area previous to 1940 was mostly agricultural and only fragmentary records are available of the extent of flooding and resultant damages. Since 1942, due to the expanding commercial and associated endeavors and the migration of city dwellers to suburban communities, the area has been almost completely transformed from an agricultural area to an urban area. Most of the urban development occurred during a period relatively free of major floods.

E-10. FEBRUARY 1940 DAMAGE SURVEYS

Damages from inundation from the February 1940 flood were estimated to be approximately $29,000. The area flooded was largely agricultural in development and now has been completely urbanized with homes and the attendant commercial endeavors. It is estimated that under present development and October 1959 prices, flooding equal to that which occurred in 1940 would cause damages of approximately $95,000.

E-11. 1955 FLOOD DAMAGE SURVEY

Immediately following the December 1955 flood, a comprehensive flood damage survey was made in the San Francisquito Creek basin. All available sources of information were consulted by field personnel of the Corps of Engineers to determine highway, railroad and utility damages caused by the flood. City, county, and State officials were contacted regarding estimated damage to public property. Inundation of homes caused the major part of the damage. A house-to-house survey was made on a nearly 100 percent basis. The total area flooded included approximately 1,200 acres of highly urbanized residential and commercial property and 70 acres of agricultural property. Approximately 700 homes were inundated. Primary damages were estimated to be $2,007,000 at that time.

E-12. APRIL 1958 FLOOD DAMAGE SURVEY

Immediately following the April 1958 flood on San Francisquito Creek, a survey was made on the same basis as the December 1955 survey for residential and commercial damage. It was found that the Palo Alto Airport and Golf Course suffered the heaviest damages from inundation. The airport area was under water and nearly two weeks were required to pump it dry. Eighty-four aircraft were damaged. An 800-foot length of new runway was damaged by ground settlement. Hangars, shops, aviation fuel tanks, and administration buildings were flooded by about two feet of water. Debris and silt were heavily deposited over the area which required a considerable amount of work to remove. Water entered the golf course clubhouse and damaged tile floors and golf equipment as well as the building. Only a relatively nominal amount of bank erosion was apparent at the time of the flood damage survey. It is believed that the erosion damage estimates following the 1940 and 1955 floods reflect a more accurate appraisal than the estimate of erosion damage made after the 1958 flood. Therefore, construction of the erosion damage-discharge curve was based primarily on the erosion damage estimates for the 1940 and 1955 floods and the estimate of erosion damage to result from occurrence of the standard project flood. Primary damages were estimated to be $297,500.

E-13. SUMMARY OF FLOOD DAMAGE SURVEYS

A summary of flood damages for the floods of February 1940, December 1955 and April 1958 follows:

Primary Flood Damage at Time of Flood

Flood date peak discharge	February 1940 3,100 c.f.s.	December 1955 5,560 c.f.s.	April 1958 4,460 c.f.s.
	(October 1959 prices and economic conditions)		
Type of damage	February 1940	December 1955	April 1958
Residential	$71,800	$1,516,000	Neg.
Commercial	5,700	125,000	$200,000
Bank erosion	4,700	113,000	30,000
Roads and bridges	1,900	32,000	2,500
Emergency aid	10,400	221,000	65,000
	$94,500	$2,007,000	$297,500

E-14. EFFECT OF FLOODS ON PROPERTY VALUES

Value of lands and improvements subject to inundation and bank erosion during flooding and the following rehabilitation period is depressed to some extent. However, in the period immediately after the December 1955 flood, large urban developments were completed in the flood plain and the trend of values for land and improvements now follows the value of property outside the flood plain. It is indicated that the hazard from floods has not been a great deterrent to urban construction in the flood-plain area. Therefore, it is considered that lands in the flood plain have approximately the same value as lands not affected by floods.

E-15. FLOOD PROBLEM

There are about 1,200 acres of urban and commercial property subject to overflow in the historical flood plain along San Francisquito Creek. This area is subject to widespread damage from high-intensity rain-type floods which may occur anytime from October to April. These floods cause extensive damage to homes and their furnishings and to commercial property. They also cause extensive rerouting and delay of traffic. The greater floods are also a serious threat to human life.

ANALYSIS OF FLOOD-DAMAGE DATA

E-16. DISCHARGE-DAMAGE CORRELATION

Analysis of available field data indicated that damages from inundation and bank erosion could be correlated with discharge. Complete data were available only for the December 1955 and April 1958 floods. For the purpose of this report, only damages occurring to present existing improvements were considered. Inundation damage to the Airport and Golf Course from floods similar to the April 1958 flood are considered non-recurrent due to the recent channel and levee improvements below Bayshore Freeway. The point of zero damage from inundation, is estimated to be between 3,000 and 4,000 c.f.s. as indicated on Plate E-3. Bank erosion occurs when discharges exceed 1,500 c.f.s. To establish damage data from a flood of the magnitude of a standard project flood, it was necessary to make hydraulic computations to ascertain the area which would be flooded and the depth of inundation throughout the flood plain. Flood plains for the standard project flood were developed and delineated on base maps. In the areas within the standard project flood plain, damage estimates were made by field survey. It was found that the major highways and railroad tracks that traverse the flood plain would cause ponding in many residential and commercial areas to depths of three feet. Damage to residential property was evaluated from a depth-damage curve to house and furnishings developed from actual damage to residences in the area from the 1955 flood as shown on Plate E-2. Damage to commercial establishments for the standard project flood was appraised in the field. Damage to highways, roads, and bridges attributable to the standard project flood was estimated from field reconnaissance and relationship to damage from the 1955 floods. The standard project flood would inundate an area of approximately 4,800 acres of which 4,300 acres are urban development and 500 acres are devoted to agricultural and non-urban uses. In this area there are some 10,000 residences with attendent commercial endeavors with a market value of approximately $275,000,000 excluding such improvements as highways, railways, public streets and public utilities. The population of the area is estimated to be 35,000. On the basis of this evaluation, the damages for a flood of the magnitude of a standard project discharge are as follows:

October 1959 Prices and Conditions

Residential	$7,161,000
Commercial	922,000
Bank erosion	236,000
Highways, roads and bridges	55,000
Emergency aid	341,000
Total	$8,715,000

E-17. FLOOD DAMAGE UNDER PRESENT CONDITIONS

The damages that would be sustained under October 1959 price levels and development conditions on occurrence of a flood equal to that of 1955 are estimated at $2,175,000 for inundation and $129,000 for bank erosion for a total of $2,304,000.

The indices utilized in adjusting the damages as of the date of occurrence to October 1959 follow:

Construction and Commodity Indices

	December 1955	October 1959
Engineering News Record		
Building cost index	478.70	555.40
Construction cost	673.13	811.40
Department of Commerce		
Furniture and household durables	117.3	123.7
Construction material (lumber and wood products)	116.8	150.8
Skilled labor	3.290	3.931
Common labor	2.097	2.624
Building material	142.1	163.9
All items	114.7	125.5
Bureau of Public Roads		
Standard composite mile	129.4	137.3
E. H. Boeke and Associates		
House frame	261.9	286.1
Commercial factory building:		
Brick and concrete	278.1	321.3
Brick and steel	275.4	318.6
Brick and wood	265.7	295.0
Frame	267.3	292.2

From the applicable price indices, the following factors to adjust December 1955 values to October 1959 prices were obtained:

Residential property	1.14
Commercial property	1.17
Emergency aid	1.21
Roads and bridges	1.07
Bank erosion	1.14

E-18. INTANGIBLE FLOOD DAMAGES

Intangible damages from floods in San Francisquito Creek basin are not appreciable. During the flood of December 1955, storm water entered the city sewer system causing raw sewage to be deposited in the lower reaches of the flood plain. Such debris normally is removed before becoming a health menace. Although no deaths have been reported from past floods, considerable anxiety is felt in the area because of the unprotected banks along the creek during flood flows. Isolation and interruption of communications attending larger floods is infrequent and numerous reroute highways provide ingress and egress to the flood area for emergency vehicles. Water for domestic supply is readily available from nearby public utility companies.

E-19. AVERAGE ANNUAL FLOOD DAMAGE

The average annual flood losses were computed by using quadrant plotting for developing the probability-damage relations. Primary damages consisting of identifiable tangible losses in the flood plain and adjacent area form the basis for the damage analysis. These damages comprise physical losses due to floods, such as damage to homes, commercial establishments, bridges, and other tangible property and equipment, cost of flood-fighting, evacuation, rescue work, and similar emergency measures; agricultural and business losses resulting from decreased production, profits, and wages; and increased cost of normal operations and living. In determining the average annual flood damages all non-recurring damages were first eliminated and the remaining damages adjusted to the October 1959 level of prices and state of economic development. Damage-discharge and discharge-frequency relations were developed for the Stanford gaging station from which damage-frequency relations expressed by annual damage curves were derived. The area under the curve represents the average annual damage due to inundation and bank erosion. These damages amount to $361,000 of which $332,000 is inundation damage and $29,000 is bank erosion based on the economic conditions prevailing in October 1959.

E-20. ADJUSTMENT FOR ANTICIPATED FUTURE ECONOMIC DEVELOPMENT

Flood damage studies generally show that future change in average annual damages from stream overflow may be expected to be related to changes in economic development in the flood plain. Since the end of World War II the area in the flood plain has experienced a very rapid rate of urban development. While a substantial portion of the flood plain has been urbanized the remaining vacant areas will be developed to higher uses as the population in the area continues to increase. As the estimate of future economic development in the area considers basin trends in population, in values and other indicators of economic growth, the first step is to classify the area into categories of land use and to estimate future land use with and without flood protection. The areas are:

a. 4,300 acres of highly developed urban and suburban properties in the standard project flood plain subject to substantial damage at the present time.

b. 500 acres of agricultural lands upon which flood damages are relatively minor under present conditions.

The 500 acres of relatively unimproved land are expected to develop to urban and suburban uses even though flood protection is not provided. It is estimated that about 300 acres of this land will be developed to higher uses by 1965, which represents seven percent of the developed acreage. Considering that several years normally intervene between project investigation and initiation of construction, it is estimated that the project would be completed by about 1965. Accordingly, an adjustment of seven percent is applied to the base average annual damages to bring them up to 1965 conditions of economic development. Furthermore, the remaining 200 acres would be developed to higher use by 1970. This represents an additional five percent of the base damages. On this basis average annual flood damages computed for 1959 conditions of economic development are increased by seven percent due to economic growth by 1965 and by an additional five percent of the base for conditions estimated to prevail after the year 1970. Consideration is given to the fact that the full increase should be taken only for the period from the present to 1965. The increase resulting from development of the remaining 200 acres by 1970 results in an average annual equivalent increase of four percent. The total average annual equivalent increase amounts to 11 percent (seven percent plus four percent).

E-21. Population forecasts for the San Francisquito Creek standard project flood plain, the city of Palo Alto and the Palo Alto township for the period 1940-2020 are:

Year	Standard project flood plain	Palo Alto	Palo Alto Township	San Francisco Bay Area
1930	-	13,652	15,838	1,575,009
1940	-	16,774	19,383	1,734,308
1950	17,800	25,475	34,404	2,681,322
1960	35,000	51,100	90,000	3,752,000
1970	47,600	68,000	112,000	4,314,000
1980	53,600	76,500	133,000	5,729,000
1990	58,900	84,200	140,000	7,425,000
2000	61,500	87,800	147,000	8,261,000
2010	64,600	92,300	168,000	11,260,000
2020	70,200	95,000	175,000	14,410,000

E-22. The second step in adjusting estimates of flood damages to reflect average economic conditions that will prevail over the next fifty years after 1965 is to consider future changes in those areas already developed. The absence of vacant lands does not preclude further economic development. In this respect consideration must be given to what would occur to existing developments and improvements if flood protection were not provided. Based upon the population forecasts for the township, the city of Palo Alto, the San Francisquito Basin, and for the San Francisco Bay area, and upon the strategic location of the flood plain, it is anticipated that there will be sufficient demand for the space in this area, so that more intensive uses are anticipated over the next 50 years. This would be accomplished by the gradual replacement of older facilities. In view of this, a study covering changes over a 30-year period of residential, commercial and public facilities and values represented therein, was conducted on a constant dollar basis so as to eliminate the influence of inflation. From these studies it was determined that the value of the main damage categories in the flood plain, 50 years hence, would be: residential 117 percent, commercial 74 percent and public facilities 96 percent greater 50 years from now than those currently found in the flood plain. It is estimated that these changes would occur at a uniform rate over the 50-year period so that average annual equivalent increases amount to: residential 34 percent, commercial 21 percent and public utilities 28 percent. To obtain a composite factor, only a proportion of the computed factors are used which are based on the proportionate share of the historic damages suffered by each damage category. The composite factor of this phase of economic development amounts to 32 percent. The total factor used to adjust flood damages computed on 1960 conditions of economic development to reflect economic conditions amounts to 43 percent (11 percent plus 32 percent). Therefore, with all future economic considerations included, average annual primary damages amount to $475,000 (332,000 x 1.43) plus $41,000 (29,000 x 1.43) bank erosion for a total of $516,000.

FLOOD CONTROL BENEFITS

E-23. PLAN OF IMPROVEMENT

The proposed plan of improvement as described in the main report provides for construction of a multiple-purpose reservoir to provide storage of 8,500 acre-feet for flood control, 3,500 acre-feet for water conservation and 600 acre-feet for siltation.

E-24. INUNDATION DAMAGES UNDER PROPOSED CONDITIONS

The flood control storage provided in the plan of improvement would give protection against damage from inundation due to floods more frequent than approximately a one percent chance flood. Reservoir regulation would result in decreasing the probability of a flood of a given magnitude below the proposed reservoir. Benefits from flood-damage reduction are computed as the difference in damage with and without the proposed project. Flood damage from inundation under these two conditions, pre-project and project, is computed by the damage-frequency method previously described. The total residual damage that would be caused by each flood is read from the discharge-damage curve. These damages were plotted through the discharge-frequency curve developed for project conditions as a basis for the damage-frequency curve as shown on Plate E-3. The residual damages thus computed are the average annual damages under project conditions. The average annual residual damages from inundation are substracted from the average annual damage under pre-project conditions to ascertain the average annual benefits tabulated below. Average annual primary residual damages under October 1959 prices are computed to be $20,000. The residual damage is proportional to damages under October 1959 prices and conditions, and 1959 prices and future conditions ($475,000 ÷ $332,000 - 1.43). Therefore, primary residual damage under 1959 prices and future conditions is $20,000 x 1.43 or $29,000. The average annual benefit is, therefore, $446,000 ($475,000 -$29,000).

E-25. BANK EROSION UNDER PROPOSED PROJECT CONDITIONS

The rate of loss from bank erosion is considered as being dependent upon the magnitude and duration of the flood. With the proposed reservoir in operation, flood peaks and duration of flows large enough to cause bank erosion would be decreased. Average annual bank erosion damage as shown on Plate E-3 is estimated to be $29,000 under October 1959 prices and conditions and under project conditions the average annual bank erosion damage is placed at $2,000. Bank erosion damages under 1959 prices and future conditions are estimated to be $41,000. The residual damage is proportionate to damages under October 1959 prices and conditions, and 1959 prices and future conditions ($41,000 ÷ $29,000 = 1.43). Therefore, residual bank erosion damage under 1959 prices and future conditions is $2,000 x 1.43, or $3,000. The average annual bank erosion benefit is $38,000. Consideration must be given to the effect of local bank protection works recently constructed by local interests to protect the stream banks in the vicinity of Bayshore Freeway. Bank erosion occurs along approximately eight miles of the stream, local interests recently have protected approximately one-half mile of the stream, or approximately six percent; therefore, average annual benefits must be reduced by six percent ($38,000 -$2,000). Therefore, the annual benefit for bank erosion is $36,000.

E-26. CHANNEL IMPROVEMENTS UNDER PROPOSED PROJECT CONDITIONS

A comparatively large amount of work has been done by Federal, county, and local interests to prevent bank cutting losses. Where the stream bottom is relatively stable, well-constructed masonry bank protection works have proven satisfactory requiring little additional annual maintenance. However, where the bottom is not stable, lowering of the streambed has caused the collapse of many masonry walls and revetments. In addition, make-shift works have been installed at various critical points. These works consisting generally of riprap, poorly anchored timber walls, and other make-shift types of construction have proved ineffective in most cases despite frequent repair and replacement.

E-27. Records of the construction cost and date of installation of the various channel improvements are practically non-existent. The replacement value of all improvements is estimated on October 1959 price levels at approximately $415,000. It is estimated that the annual cost of these works is five percent of the total costs or $21,000 annually.

E-28. The average annual bank protection expense under proposed project conditions is estimated by assuming that such expenses would be reduced in the same proportion as would the damages from bank erosion. It is estimated that the average annual damages resulting from loss of land by bank erosion would be decreased from $29,000 under 1959 prices and conditions to $2,000 under proposed project conditions, or a reduction of approximately 93 percent. The average annual benefit under project conditions for reduction of bank protection expense, therefore, is 93 percent of $21,000, or $20,000.

E-29. WATER CONSERVATION BENEFITS UNDER PROPOSED PROJECT CONDITIONS

Water made available from the firm yield of the conservation pool will be used principally for domestic purposes. To determine the benefits from domestic and industrial water supply, the most economical alternate means of obtaining water was used. The least costly source of alternative supply is the Hetch Hetchy system, a property of the city of San Francisco. From studies described in Appendix D, it was found that the incremental cost of Hetch Hetchy water was $70 per acre-foot at Palo Alto. The cost of treating and conveying water developed from San Francisquito Creek would be $17 per acre-foot as developed from studies presented in Appendix D. This would leave a net benefit of $53 per acre-foot for water developed at the damsite. The annual benefits of 1,500 acre-feet of firm yield at $53 per acre-foot are $79,500.

E-30. SUMMARY OF BENEFITS UNDER FUTURE CONDITIONS AND 1959 PRICES

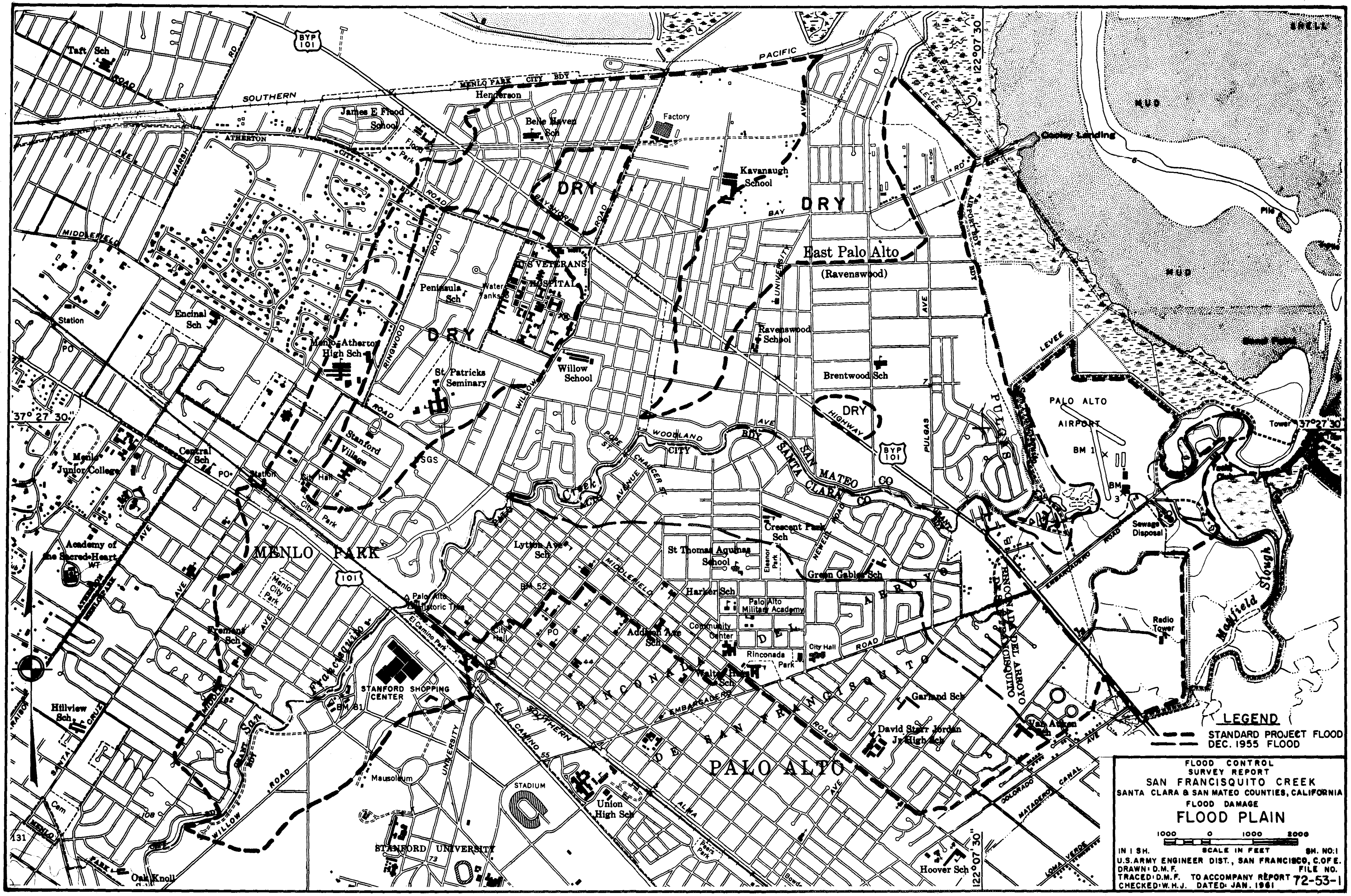
For economic evaluation of costs versus benefits, the average annual benefits under 1959 prices and all future conditions are as follows:

Summary of Average Annual Benefits

	Benefits
Inundation	$446,000
Bank erosion	36,000
Channel improvements	20,000
Water conservation	79,500
Total, average annual benefits	$581,500

E-31. DAMAGE UNDER FUTURE CONDITIONS

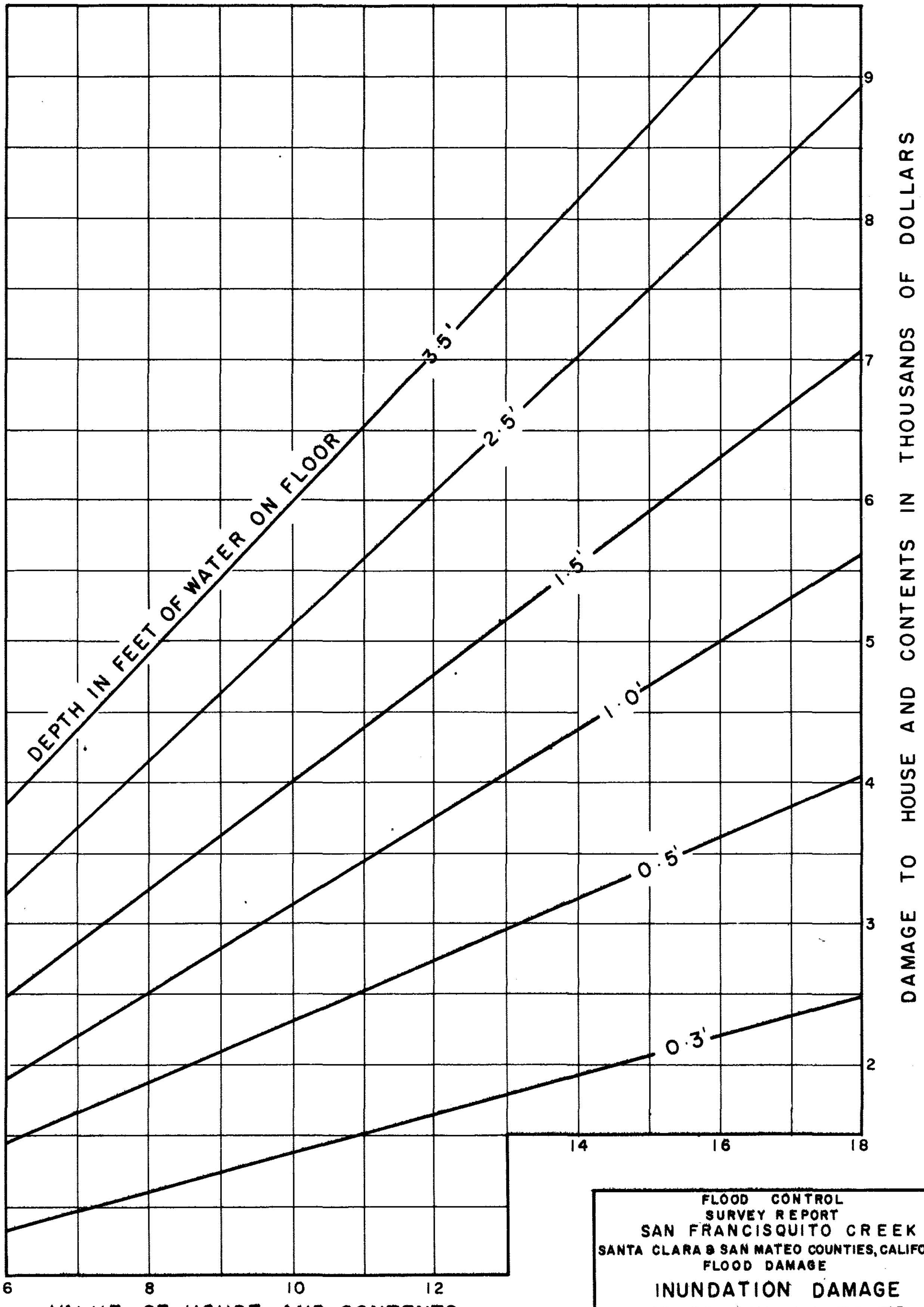
In compliance with Senate Resolution 148 dated January 1958, a study was made to ascertain the effect of a project designed to offer protection to the flood plain for 100 years. Computations indicate that the difference in growth, allowing for a longer development time for the two periods, is approximately one percent. Therefore, average annual benefits under a project designed to offer protection for 100 years would be approximately the same as those estimated for the 50-year period.



FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
FLOOD DAMAGE
FLOOD PLAIN

IN 1 SH. SH. NO: 1
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E.
DRAWN: D.M.F. FILE NO.
TRACED: D.M.F. TO ACCOMPANY REPORT 72-53-1
CHECKED: W.H.J. DATED: JAN. 1961

PLATE E-1

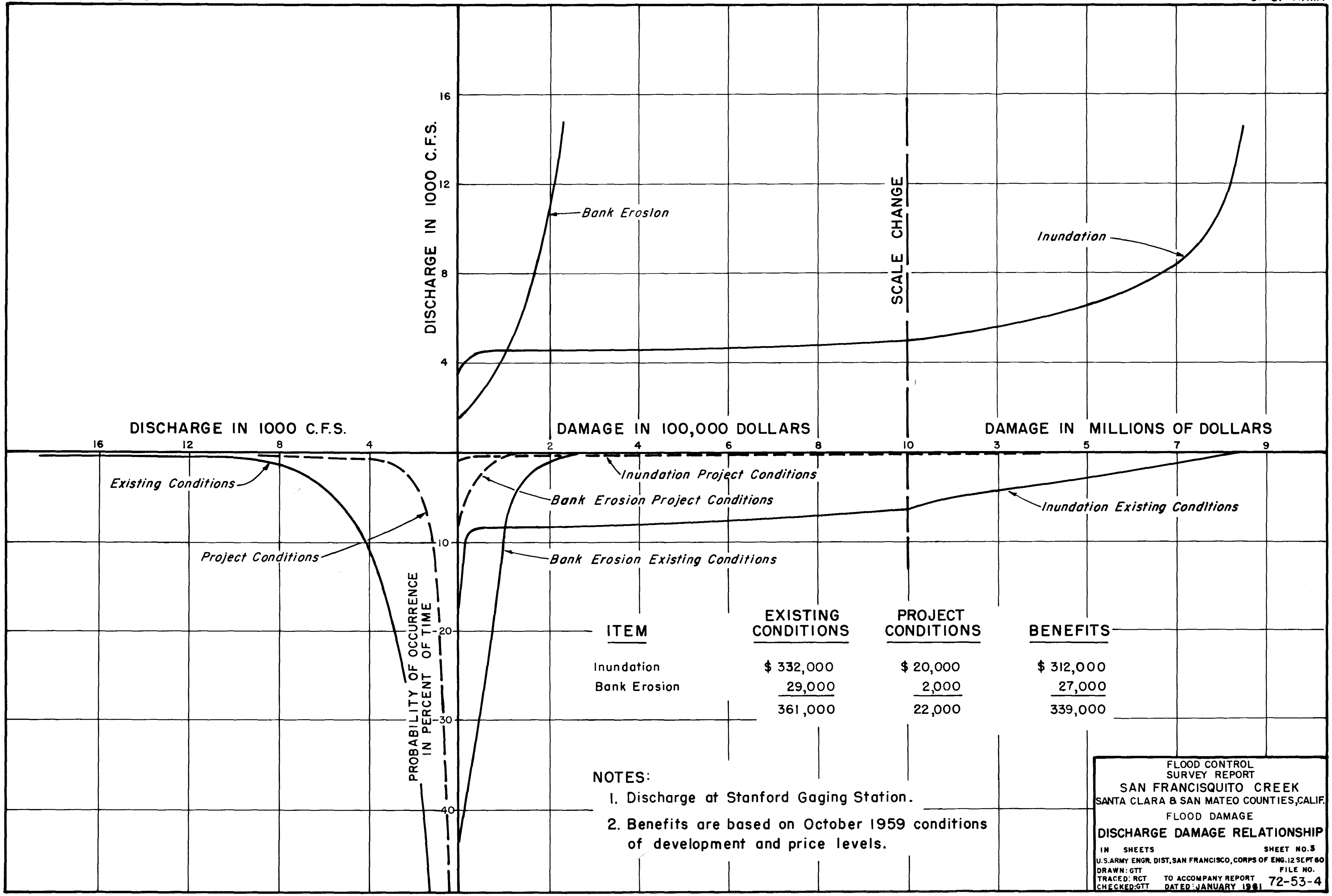


NOTE: Damage to Land not Included

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA
FLOOD DAMAGE

INUNDATION DAMAGE HOUSE AND CONTENTS

IN 2 SHEETS SHEET NO. 2
U.S. ARMY ENGINEER DIST. SAN FRANCISCO, C.OF E.
DRAWN: K.A.F. FILE NO.
TRACED: J.C.B. TO ACCOMPANY REPORT
CHECKED: W.H.J. DATED: JANUARY 1961 72-53-2



ITEM	EXISTING CONDITIONS	PROJECT CONDITIONS	BENEFITS
Inundation	$ 332,000	$ 20,000	$ 312,000
Bank Erosion	29,000	2,000	27,000
	361,000	22,000	339,000

NOTES:

1. Discharge at Stanford Gaging Station.
2. Benefits are based on October 1959 conditions of development and price levels.

FLOOD CONTROL
SURVEY REPORT
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIF.
FLOOD DAMAGE
DISCHARGE DAMAGE RELATIONSHIP
IN SHEETS SHEET NO. 3
U.S. ARMY ENGR. DIST, SAN FRANCISCO, CORPS OF ENG. 12 SEPT 60
DRAWN: GTT FILE NO.
TRACED: RCT TO ACCOMPANY REPORT 72-53-4
CHECKED: GTT DATED: JANUARY 1961

REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX F

COMMENTS BY OTHER AGENCIES

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REPORT OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES

SAN FRANCISQUITO CREEK
SANTA CLARA AND SAN MATEO COUNTIES, CALIFORNIA

APPENDIX F

COMMENTS BY OTHER AGENCIES

GENERAL

F-1. SCOPE

This appendix presents the comments of other Federal and non-Federal agencies relative to their interest in the proposed reservoir project for flood control and water conservation on San Francisquito Creek, California.

COMMENTS

F-2. CONSENSUS OF COMMENTS

Comments of other interested agencies resulting from coordination at field level are presented later in this appendix. As may be noted, therefrom, comments of these agencies are favorable toward construction of the proposed reservoir project. It is recognized that minor modifications will be necessitated in the design stage to make the proposed project compatible with the Atomic Energy Commission's accelerator and the State Division of Highway's Freeway System. Based on present plans, it is considered that these facilities will not affect the dam or create major changes in the reservoir function.

F-3. NATIONAL PARK SERVICE

Correspondence and a report dated May 1959 from the National Park Service are included as Exhibit "A" of this appendix. The National Park Service has reviewed advance copies of this report and appendices and believes that the local administering agency should be encouraged to take all feasible steps to derive maximum recreation benefits from the proposed reservoir impoundment.

F-4. FISH AND WILDLIFE SERVICE

Comments of the Fish and Wildlife Service based on review of advance copies of this report and appendices are presented as Exhibit "B" in this appendix. The Service recommends that cooperation with the

California Department of Fish and Game and the Bureau of Sport Fisheries and Wildlife be pursued in formulating plans for management of the project in the interests of fish life. Also, that lands required for the reservoir be acquired in fee insofar as possible to assure the highest public use of the reservoir for fishing and other types of recreation.

F-5. BUREAU OF RECLAMATION

Review of advance copies of this report by the Bureau of Reclamation indicates that the proposed reservoir project does not interfere with the Bureau's study for water service in the Santa Clara County area. The letter containing comments of the Bureau of Reclamation is presented as Exhibit "C" in this appendix.

F-6. ATOMIC ENERGY COMMISSION

Comments of the Atomic Energy Commission are presented as Exhibit "D" in this appendix. The comments as presented indicate that the accelerator and reservoir project can be made compatible with each other.

F-7. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

The comments from the Department of Health, Education and Welfare are presented as Exhibit "E" in this appendix. The Department calls attention to the necessity for complete treatment and quality control of surface water taken from the proposed reservoir for domestic uses. Also, it is noted that the proposed project will reduce the danger of flood damage to sewage works and with reduced flood danger should lead to a safer environment.

F-8. SOIL CONSERVATION SERVICE

Exhibit "F" contained in this appendix presents the comments of the Soil Conservation Service. The Service recognizes the need for flood prevention on San Francisquito Creek and for the supplemental water supply to be developed in this part of Santa Clara County.

F-9. BUREAU OF PUBLIC ROADS

Exhibit "G" presented in this appendix contains the comments of the Bureau of Public Roads. In asmuch as the design is being coordinated with the local agencies responsible for the Federal-aid highways involved, the Bureau's interest is satisfied.

F-10. STATE OF CALIFORNIA

The Department of Water Resources has consolidated the comments of the interested State agencies and these are presented as Exhibit "H" in this appendix. This agency believes (1) the estimated construction cost of the proposed dam and reservoir is about ten percent low; (2) there is question as to the economic justification for the inclusion of conservation storage in the reservoir; and (3) that there is no question regarding the need and justification for the flood-control storage proposed.

RESOLUTIONS

F-11. GENERAL

Copies of resolutions from the counties of San Mateo and Santa Clara indicating willingness to cooperate in the proposed reservoir project are presented on following pages.

COPY

COUNTY of SAN MATEO
Flood Control District
COURTHOUSE - REDWOOD CITY - CALIFORNIA
EMerson 9-1441 Ext. 471

Don S. Wilson
County Engineer
A. B. Blakely
Deputy Engineer
Aaron E. Harris
Manager

November 14, 1960

District Engineer
Corps of Engineers, U. S. Army
Box 3050, Rincon Annex
San Francisco 19, California

Dear Sir:

Enclosed please find copy of Resolution No. 15630, Board of Supervisors, County of San Mateo, State of California, passed on November 9, 1960. The above entitled resolution is one of assurance to the District Engineer that San Mateo County Flood Control District will provide the required local cooperation for the San Francisquito Creek Flood Control Project.

Very truly yours,

/s/ Aaron E. Harris
AARON E. HARRIS
MANAGER
SAN MATEO COUNTY FLOOD CONTROL DISTRICT

AEH/o'n
Encl. Resolution No. 15630

cc: Mr. Donald K. Currlin, Manager
Santa Clara Flood Control and Water
Conservation District
County Administration Building
1st and Rosa Streets - San Jose 10.
(with enclosure)

COPY

RESOLUTION NO. 15630

BOARD OF SUPERVISORS, COUNTY OF SAN MATEO, STATE OF CALIFORNIA

RESOLUTION ASSURING THE DISTRICT ENGINEER, CORPS OF ENGINEERS U. S. ARMY, THAT SAN MATEO COUNTY FLOOD CONTROL DISTRICT WILL PROVIDE THE REQUIRED LOCAL COOPERATION FOR THE SAN FRANCISQUITO CREEK FLOOD CONTROL PROJECT

RESOLVED, by the Board of Supervisors, as the ex-officio governing body of the San Mateo County Flood Control District, State of California, that

WHEREAS, the San Francisco District Engineer, Corps of Engineers, U. S. Army, has advised local jurisdictions that the Corps of Engineers "Review Survey Report" on the San Francisquito Creek, in San Mateo and Santa Clara Counties, for flood control and allied purposes, has been substantially completed; and

WHEREAS, the County Engineer of San Mateo County, ex-officio Engineer of San Mateo County Flood Control District, has reviewed the preliminary plans and descriptions of the proposed project on San Francisquito Creek submitted to him by the Corps of Engineers, and has stated that he concurs in the general plan of improvement, and the conditions of local cooperation for said project; and

WHEREAS, the San Francisco District Engineer, Corps of Engineers, U. S. Army, has requested a statement or resolution of this Board indicating the willingness and ability of local interests to meet the conditions of local cooperation on said project:

NOW, THEREFORE, IT IS HEREBY FOUND, DETERMINED AND ORDERED, that

(1) It is in the public interest for the Flood Control Project on San Francisquito Creek to be implemented and completed at as early a date as is possible; and

(2) It is the policy of this Board of Supervisors as the ex-officio governing body of San Mateo County Flood Control District, in cooperation with Santa Clara County Flood Control and Water Conservation District, to take any and all actions legally within this Board's power to meet said conditions of local cooperation on said project on San Francisquito Creek for flood control and allied purposes, as follows:

(a) Subject to passage of proposed legislation by the State of California to authorize reimbursement to said Districts, to furnish without cost to the United States all lands, easements, rights of way and relocations allocated to flood control and presently estimated to have a value of $2,354,000.00, being 83.4 percent of the total value of lands, easements, rights of way and relocations required for said project.

(b) Repay to the United States Treasury 16.6 percent of the total project cost expended by the United States for said project, presently estimated at $1,288,000.00, plus interest during construction, in not more than 50 installments with interest at a rate established at the time of construction by the Secretary of the Treasury, in consideration of water conservation benefits.

(c) Hold and save the United States free from damages due to the construction of said project.

(d) Maintain and operate said project upon its completion, the operations for flood control to be in accordance with regulations prescribed by the Secretary of the United States Army therefor.

(e) Satisfy all claims concerning water rights arising from the construction, maintenance and operation of said project.

(f) Enter into an Agreement as to method of regulation and use of the reservoir for conservation involved in said project. in a manner consistent with Federal and State laws subject to flood control priorities.

(g) Prevent any encroachment of the stream channel downstream from the dam involved in said project to the mouth of said stream channel which would interfere with the proper functioning of the improvements to be constructed in connection with said project or would lessen their beneficial effects or would reduce the capacity of said stream channel existing in 1960.

* * * * *

Regularly passed and adopted this 9th day of

November, 1960.

Ayes and in favor of said resolution

Supervisors:

T. LOUIS CHESS

W. M. WERDER

ALVIN S. HATCH

E. R. McDONALD

(ENDORSED)

BOARD OF SUPERVISORS

FILED
Nov 9 - 1960
JOHN A. BRUNING, Clerk

BK ______ Page ______

Noes and against said resolution:

Supervisors: None

Absent Supervisor: THOMAS J. CALLAN

E. R. McDONALD
Vice Chairman, Board of Supervisors
County of San Mateo, State of
California

ATTEST:
(SEAL) JOHN A. BRUNING
Clerk of Said Board of Supervisors

STATE OF CALIFORNIA) ss
COUNTY OF SAN MATEO)

JOHN A. BRUNING, County Clerk of the County of San Mateo, State of California, and ex-officio Clerk of the Board of Supervisors thereof, does hereby certify that the above and foregoing is a full, true and correct copy of Resolution No. 15630 entered in the minutes of said board.

In Witness Whereof, I have hereunto set my hand and the seal of said Board this 16th day of November 1960

JOHN A. BRUNING, CLERK
By /s/ June M. Lynch
Deputy

SANTA CLARA COUNTY FLOOD CONTROL
AND
WATER CONSERVATION DISTRICT

DONALD K. CURRLIN
MANAGER - COUNSEL

GEORGE H. PRIME
SUPERVISING ENGINEER

112 HAMLINE STREET
SAN JOSE 10, CALIFORNIA
CYPRESS 5-1050

December 2, 1960

Mr. Ruben Johnson, Chief
Planning and Reports Division
Corps of Engineers, U.S. Army
180 New Montgomery Street
San Francisco 19, California

Dear Mr. Johnson:

Enclosed are two copies of a resolution assuring the District Engineer of the U.S. Army Corps of Engineers that the Santa Clara County Flood Control and Water Conservation District will provide the required local cooperation for the San Francisquito Creek Flood Control Project.

Very truly yours,

Donald K Currlin
DONALD K. CURRLIN
Manager-Counsel

DKC:fs
Encls.

COPY

ZONE NW-1
PROJECT NO. 2
SAN FRANCISQUITO CREEK

RESOLUTION ASSURING THE DISTRICT ENGINEER, CORPS OF ENGINEERS U. S. ARMY, THAT SANTA CLARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT WILL PROVIDE THE REQUIRED LOCAL COOPERATION FOR THE SAN FRANCISQUITO CREEK FLOOD CONTROL PROJECT.

RESOLVED, by the Board of Supervisors of the Santa Clara County Flood Control and Water Conservation District, State of California, that

WHEREAS, the San Francisco District Engineer, Corps of Engineers, U. S. Army, has advised local jurisdictions that the Corps of Engineers "Review Survey Report" on the San Francisquito Creek, in San Mateo and Santa Clara Counties, for flood control and allied purposes, has been substantially completed; and

WHEREAS, the San Francisco District Engineer, Corps of Engineers, U. S. Army, has requested a statement or resolution of this Board indicating the willingness and ability of local interests to meet the conditions of local cooperation on said project:

NOW, THEREFORE, IT IS HEREBY FOUND, DETERMINED AND ORDERED that

1. It is in the public interest for the Flood Control Project on San Francisquito Creek to be implemented and completed at as early a date as is possible; and

2. It is the policy of this Board of Supervisors, in cooperation with San Mateo County Flood Control District, to take any and all actions

legally within this Board's power to meet said conditions of local cooperation on said project on San Francisquito Creek for flood control and allied purposes, as follows:

(a) Subject to passage of proposed legislation by the State of California to authorize reimbursement to said Districts, to furnish without cost to the United States all lands, easements, rights of way and relocations allocated to flood control and presently estimated to have a value of $2,354,000.00, being 83.4 percent of the total value of lands, easements, rights of way and relocations required for said project.

(b) Repay to the United States Treasury 16.6 percent of the total project cost expended by the United States for said project, presently estimated at $1,288,000.00, plus interest during construction, in not more than 50 installments with interest at a rate established at the time of construction by the Secretary of the Treasury, in consideration of water conservation benefits.

(c) Hold and save the United States free from damage due to construction of said project.

(d) Maintain and operate said project upon its completion, the operations for flood control to be in accordance with regulations prescribed by the Secretary of the United States Army therefor.

(e) Satisfy all claims concerning water rights arising from the construction, maintenance and operation of said project.

(f) Enter into an Agreement as to method of regulation and use of the reservoir for conservation involved in said project in a manner consistent with Federal and State laws subject to flood control priorities.

(g) Prevent any encroachment of the stream channel downstream from the dam involved in said project to the mouth of said stream channel which would interfere with the proper functioning of the improvements to be constructed in connection with said project or would lessen their beneficial effects or would reduce the capacity of said stream channel existing in 1960.

PASSED AND ADOPTED by the Board of Supervisors of the Santa Clara County Flood Control and Water Conservation District, State of California, this 28th day of November, 1960, by the following votes:

AYES: Supervisors Della Maggiore Hubbard Mehrkens Levin Weichert
NOES: Supervisors None
ABSENT: Supervisors None

/s/ Sam P. Della Maggiore

Chairman of the Board of Supervisors

ATTEST: JEAN PULLAN, Clerk of said
Board of Supervisors

/s/ Jean Pullan

March 3, 1849

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
180 New Montgomery Street
San Francisco 5, California

IN REPLY REFER TO:
L7423

September 12, 1961

Colonel John A. Morrison
District Engineer
U. S. Army Engineer District
Box 3050, Rincon Annex
San Francisco 19, California

Dear Colonel Morrison:

In compliance with a verbal request made by Mr. Gerald Trail and review of Corps of Engineers' Report of Survey and Appendices for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California, dated January, 1961, we have revaluated the recreation potential of the project on the basis that an acreage of land above the Corps' original proposed take-line elevation 302 feet be acquired, at Federal cost, for the purpose of providing minimum basic public use facilities appropriate to the project.

In our subject letter of January 13, 1961, following our review of the advance copy of your Report of Survey, we stressed the importance of provision of sufficient lands for public use in connection with this proposed project which would be centrally located within a rapidly growing complex of population. We also sited the adverse effect on public use development which would be caused by the Atomic Energy Commission's locating a linear accelerator diagonally across the north side of the reservoir area whereby the public use potential of the north and part of the east side of the reservoir would be nullified.

In line with the President's new policy of providing lands for public use at all reservoirs and the Corps' interpretation of this policy we now understand it is your plan to acquire all those lands located on the northeasterly side of the reservoir which are contained within the area bound by the dam on the southeast, the reservoir on the west, the linear accelerator on the north and the approved Junipero Sierra

Exhibit "A"

Freeway Route on the east. This would provide an area of approximately fifty-five acres which would, in part, meet the minimum basic public use potential appropriate to the project.

Although not considered in the plan of development, as of this date, we still believe serious consideration should be given either by the Federal Government or the local sponsoring agency to also acquire the relatively steep, wooded continuous buffer strip along the south side of the reservoir, extending from the existing Searsville Lake to the proposed San Francisquito Dam, as recommended in our report of May, 1959. In fact, this area now becomes more important to the public use potential of the project than before due to elimination of the north side public use development area by the linear accelerator. It would serve as the only possible connecting link between the existing Searsville Lake recreation area and the future San Francisquito Reservoir area. This strip although mainly steep in topography is the only area adjacent to the reservoir which, for the most part, is pleasantly wooded and would serve as an objective for boaters from the main public use area on the east side. Acquisition of this buffer strip would also permanently eliminate the inevitable situation of incompatible steep hillside residential or other development along the south side of the reservoir which invariably results in difficult erosion, sanitation and encroachment problems contrary to the original project intent.

Basing public use development only on the acquisition of the fifty-five acres as earlier described, it is estimated that minimum basic public use developments (Federal) costs would be approximately $350,000. These costs are derived as follows:

Minimum Basic Public Recreation Development Facilities

Roads (access and circulation) 1½ miles	$ 75,000
Parking areas, 300 cars	75,000
Picnic areas, 100 at $200	20,000
Sanitation facilities	40,000
Water systems	25,000

Exhibit "A"

Boat docking and launching facilities	10,000
Beach improvement for swimming	10,000
Trails, walks, signs and markers	5,000
Conservation landscaping and planting	15,000
Miscellaneous	5,000
Subtotal	$280,000
Additional contingencies, plans and overhead (25% of $280,000)	70,000
Total minimum basic public recreation development (Federal) costs	$350,000

With the elimination of the north shore reservoir area, the proposed golf course, etc., by the construction of the linear accelerator and the confinement of the more expanded recreation facilities to the one east side reservoir area, it is estimated that the total non-Federal recreation cost could be reduced from $1,300,000 (as indicated in our original report) to $375,000. No further consideration of this advanced phase of development is made in this analysis.

Estimated annual costs, visitation and annual monetary benefits with minimum basic public recreation developments are revised as follows:

Estimated Annual Costs

With Minimum Basic Public Recreation Development

1. Annual equivalent of construction costs

   $375,000 x .035 (50 year amortization factor at 2½%) . . . . $ 12,250

2. Annual cost of interim replacement of the nondurable recreation facilities x 25 year sinking fund replacement factor

   $280,000 - $75,000 (roads) = $205,000
   $205,000 x 25% (contingencies) = $51,250
   $205,000 / $51,250 = $256,250 x .029 . . $ 7,430

Exhibit "A"

3. Annual operation and maintenance costs

100,000 visitor days x \$.10 = \$10,000
\$350,000 construction costs
x \$.03 = 10,500 \$ 20,500
\$ 40,180

Rounded to \$ 40,000

Visitation

Visitor days (annual). . . . . (with minimum basic public use development)	100,000
Additional visitor days (annual) . . . . . . (with expanded recreation development)	400,000

Annual Monetary Benefits

With minimum basic public use development 100,000 visitor days x \$1.60	\$160,000
With expanded recreation development 500,000 visitor days x \$1.60	\$800,000

It is further recommended that, in the event the so-called approved alignment of the proposed Junipero Sierra Freeway Route should be moved from its present alignment any distance farther to the northeast that this Freeway still should be considered as the logical east boundary of the proposed park area and that all intervening lands located between the reservoir and Freeway be acquired either by the Federal Government or by the ultimate administering agency for public park purposes.

We appreciate the opportunity of again reviewing the public use potential of this project based on the assumption that minimum basic public use lands would be included and acquired as a Federal cost to the project.

Sincerely yours,

Herbert Maier
Acting Regional Director

Exhibit "A"

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
180 New Montgomery Street
San Francisco 5, California
REGION FOUR

IN REPLY REFER TO:

January 13, 1961

Col. John A. Morrison
District Engineer
U. S. Army Engineer District
Corps of Engineers
Box 3050, Rincon Annex
San Francisco, California

Dear Colonel Morrison:

We have reviewed the advance copy of your Report on Survey for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California, which was received with your letter of December 9, 1960.

We find that a number of changes in your plan have occurred since completion of our report, all of which appear quite detrimental to the ultimate development of the project area as a valuable public use center which would be located in the midst of the rapidly growing Metropolitan San Francisco Bay Area.

It is noted that local interests will now be required to furnish all lands, easements and rights-of-way for the project. We further understand that these lands would normally not extend above the crest of dam at elevation 302. In other words, it would also be entirely the responsibility of the local administering agency to acquire any adjacent lands which might be developed for public recreation purposes.

The report also reveals that the spillway design has been changed from a controlled (gated) to an ungated structure (shown Plate 3 of the report) which will permit the unrestricted release of flood flows to elevation 259. This alone greatly reduces the project's potential recreation value as it eliminates the possibility of retaining any flood waters for public use purposes during the summer recreation season. Further it results in a body of water of less expanse than would have been possible with the original plan.

Since our report was completed another factor, detrimental to park and recreation development, in the form of a linear accelerator (shown on Plate 2) has been proposed by the Atomic Energy Commission which, we understand, would practically eliminate the valuable area proposed for public use which is located between the Sand Hill Road and the north side of the reservoir.

Exhibit "A"

It was our understanding, when we wrote our report in May 1959, that minimum basic recreation facilities, as well as lands upon which to install them, would be furnished as part of the Federal cost of the project. Further, that additional public use lands and expanded recreation facilities would be installed by the local administering agency. Elimination of the possibility of the Federal Government assisting in the initial establishment of this recreation area, because it has been determined that the recreation benefits are of local interest only, throws an additional burden upon the local administering agency. Recreation visitation, as stated in our report, would be mainly of local derivation. However, with the tremendous increase in Bay Area population and construction of the approved Junipero Serra Freeway through the reservoir area, much visitation would also be derived from centers of population both north and south of San Mateo County.

Even considering all the above factors, which appear detrimental to development of the project area from a public use standpoint, nevertheless it is believed that the local administering agency should be encouraged to take all feasible steps to derive maximum recreation benefits from this impoundment. This should include acquisition of sufficient public lands, especially on the east side of the reservoir including all that portion between the approved Junipero Serra Freeway and the reservoir and the strip on the south side extending from Searsville Lake to the proposed dam to provide areas for public recreation development. Further, that every effort be exerted by that agency to maintain the reservoir at as high an elevation as possible, consistent with project purposes, in order to best serve the public recreation development which they may desire to develop in relation to the reservoir project.

We appreciate the opportunity of reviewing and commenting on your advance report. As requested the report and Appendix A (Hydrology) are returned herewith.

Sincerely yours,

Lawrence C. Merriam
Regional Director

Attachments (2)

A-2

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
180 New Montgomery Street
San Francisco 5, California

IN REPLY REFER

L7423

May 27, 1959

Col. John S. Harnett
District Engineer
U. S. Army Engineer District
S. F. Corps of Engineers
Box 3050, Rincon Annox
San Francisco 19, California

Dear Colonel Harnett:

In accordance with your letter request of June 10, 1958, subsequent discussions with members of your staff, and pursuant to the authority of the Park, Parkway and Recreation - Area Study Act of June 1936, we are submitting herewith, two copies of a reconnaissance report on the proposed San Francisquito Creek Reservoir located in San Mateo County, California.

This report is based on information available as of May 15, 1959.

In the event the Corps proceeds with further planning on this proposal, we request that the National Park Service be notified so that further investigations, including archeology can be undertaken.

Sincerely yours,

Lawrence C. Merriam
Regional Director

Enclosures (2)

Reconnaissance Report

RECREATION USE AND DEVELOPMENT

SAN FRANCISQUITO CREEK RESERVOIR

Central Valley - San Francisco Basin

California

Report prepared by

Region Four, National Park Service

Department of the Interior

for

San Francisco District

U. S. Corps of Engineers

Department of National Defense

May 1959

Code XLIV/106

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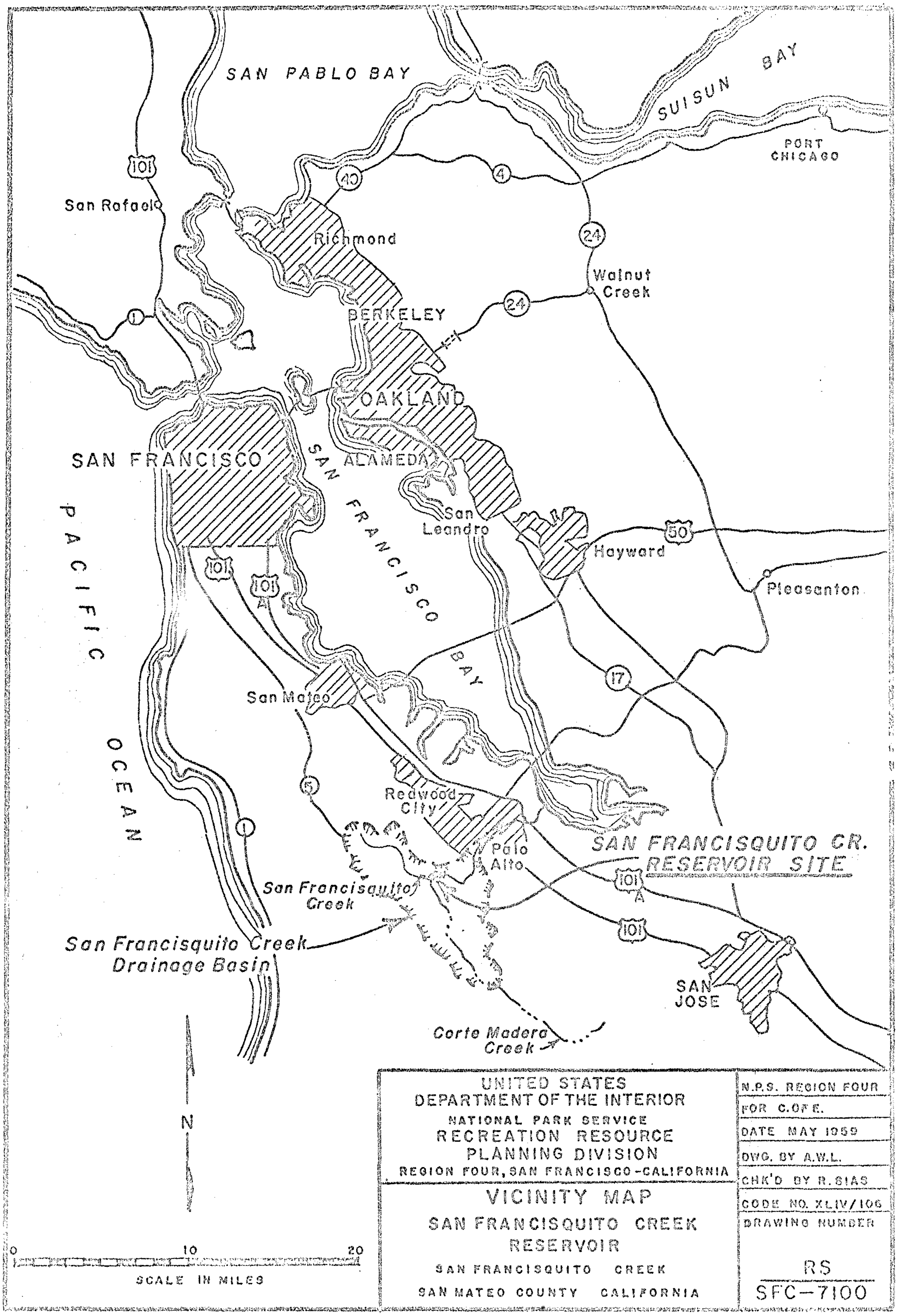

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
RECREATION RESOURCE
PLANNING DIVISION
REGION FOUR, SAN FRANCISCO-CALIFORNIA

VICINITY MAP
SAN FRANCISQUITO CREEK
RESERVOIR
SAN FRANCISQUITO CREEK
SAN MATEO COUNTY CALIFORNIA

N.P.S. REGION FOUR
FOR C.OF E.
DATE MAY 1959
DWG. BY A.W.L.
CHK'D BY R. SIAS
CODE NO. XLIV/106
DRAWING NUMBER
RS
SFC-7100

Reconnaissance Report

RECREATION USE AND DEVELOPMENT

SAN FRANCISQUITO CREEK RESERVOIR

San Mateo County, California

INTRODUCTION

The San Francisquito Creek impoundment proposal is a U. S. Corps of Engineers project for the development of a multi-purpose reservoir on San Francisquito Creek, in San Mateo County, California. The District Engineer has requested the National Park Service to participate in this project in a consultative capacity in connection with potential recreation phases of reservoir use. Authority for such cooperation stems from the Park, Parkway and Recreation-Area Study Act of June 1936.

SUMMARY

Based on the present status of project planning it is found that circumstances attending the location of the proposed reservoir, existing conditions, and factors involving access and the population affected indicate valuable recreation possibilities.

It is concluded that if reservoir conditions, operation and available land are favorable as indicated in this report, the San Francisquito Creek impoundment would have a recreation potential warranting full consideration as a legitimate phase of utilization in the long-range public interest.

It is concluded that realization of the indicated potential would be dependent on provision of adequate recreation development and facilities, competently managed by a qualified local agency.

The only existing public recreation values or facilities that may be affected by this reservoir consist of approximately 25 to 30 portable picnic units below the dam at Searsville Lake. These facilities

would not be inundated except during extreme flood storage operation of San Francisquito Creek Reservoir.

As of this writing, no historical or archeological values affecting recreation interests, have been investigated. It is however doubtful if there are any such values of significance involved.

It is recommended that, in the event the project is constructed as presently planned, the Federal Government participate in recreation development by provision of sufficient lands and minimum basic facilities essential to the health, safety and protection of the visiting public provided subsequent administration and maintenance by a qualified public agency is assured. The cost of such minimum basic recreation facilities, exclusive of lands, is broadly estimated at $375,000.

For full realization of recreation values the minimum basic facilities should be expanded at a non-Federal cost of an estimated $1,300,000, exclusive of additional land costs.

It is estimated that monetary benefits stemming from recreation uses under favorable conditions would be equivalent to $208,000 annually with minimum facilities accommodating some 130,000 visitor days. With full development along the lines indicated in this report the monetary benefit equivalent could be $1,200,000 annually, on the basis of three-quarters of a million visitors.

It is recommended that full consideration be accorded San Mateo County Park and Recreation Administration interests in this project as project plans are advanced.

GENERAL DESCRIPTION OF AREA

Location

This reservoir will be located on the protected eastern slope of the San Francisco peninsula relatively at the hub of population between San Francisco and the rapidly growing Santa Clara-San Jose metropolitan areas. Roughly eight air miles from

San Francisco Bay, it will create a 200 acre (approximately) reservoir at conservation pool level, on Stanford University property in the foothills approximately 12 miles southwest of the city of Palo Alto.

Accessibility

The reservoir area is readily accessible via excellent paved highways and roads from Palo Alto, Menlo Park, Atherton, Redwood City and other significant peninsular communities including the San Jose-Santa Clara complex and San Francisco. Some of these access roads are scheduled for early improvement. A major proposal by the California Division of Highways envisions a freeway which will cross the northeast arm of the reservoir.

Purpose of reservoir

The Corps of Engineers' plan of development for the San Francisquito Project contemplates a rolled earth fill dam across San Francisquito Creek which will create a reservoir with a total gross storage capacity of 13,100 acre feet. The dam is to have a crest elevation of 300 feet above mean sea level, rising 100 feet above the stream bed. The storage of 13,100 acre feet will be apportioned as follows:

Purpose	Area	Capacity	Elevation
Flood Control	450 acres	8,500 a.f.	295
Conservation	200 acres	3,500 a.f.	262
Reservation for silt	75 acres	1,100 a.f.	235

It is contemplated, based on firm conservation yield, that this reservoir will fill to maximum water surface elevation of 295 feet only once in 150 years, at which time about 450 acres would be inundated. Maximum storage during the average year will reach elevation 262 feet, forming a conservation pool covering about 200 acres, while normal recession during the same year will be 8 feet to elevation 254 feet. During a dry year maximum elevation might not rise above elevation 258 while recession might reach as much as 23 feet to elevation 235. It is not contemplated that this extreme dead storage elevation will be reached more than twice during the fifty year life of the project. Maximum pool elevations will normally appear in April or early May while drawdown will depend upon conservation releases. In the interest of public recreation it is recommended that the flood control (space of 8,500 acre feet) pool be permitted to remain full after danger of serious rains has passed in the spring for benefit of public recreation during the late spring and summer months and be released immediately before the rains are anticipated in the fall.

Under the operational procedure presently proposed, the Corps of Engineers will be responsible for the operation of the flood control aspects of the reservoir. The conservation storage will be regulated according to local interests.

Physical characteristics

The entire north side of the reservoir is gently undulating terrain all of which will be excellent for public use development. Likewise the lands located between the Portola Road and Searsville Lake on the south side are similar in character. In fact some of these lands located northwest of the Searsville Dam are already used for picnicking and other day uses by Searsville Lake visitors. A minor number of these picnic sites will be inundated by the proposed San Francisquito Creek Reservoir when it is filled.

The south bank of this reservoir from Searsville Lake to the proposed San Francisquito dam site will be generally precipitous for an average distance of 500 feet back from full reservoir or approximately to the 500 feet elevation. Above that elevation, the terrain will be more undulating, with some points reaching slightly over 600 feet. This area provides pleasing vistas overlooking the proposed reservoir to the north and east. Picturesque rock outcroppings are in evidence.

As in topography, extreme contrast is evident in the vegetative cover around this site. Both will add to the public interest that will be derived from the proposed project.

The entire north side is a predominately open, rolling, grass covered area with only an occasional tree or cluster of mature California live oaks, or specimen eucalyptus planted in an early day. The precipitous south shore is thickly wooded with more imature native species including oak, sycamore, some pine and an occasional planted coastal redwood at the upper end along with introduced eucalyptus in areas adjacent to Searsville Lake.

Although the north side is now rolling grassland conspicuously void of native tree growth, the entire area will readily respond to proper landscape planting appropriate to major public use development.

Climate

The reservoir area is located low in the hills a few miles southeast from San Francisco Bay above the city of Palo Alto. It normally receives in excess of 25 inches of precipitation annually. Most rainfall occurs between December and April, with only traces of rain during fall and late spring months.

Winter night temperatures may occasionally reach freezing but days through the year are normally warm. During July and August extreme day temperatures may reach into the 90's but cool evenings prevail due to the nearness to the ocean.

Typical of the lakes and reservoirs of this area which are protected from the west by a low mountain range, the area could actually be used for public use the year around.

History and archeology

No special history or archeology investigations have been conducted in connection with this broad reconnaissance type report. No such values of significance are known to exist in the project area.

Present recreation value

At present the reservoir area is of value, scenically, as a very pleasant California woodland type landscape. It is protected from adverse exploitation by the nature of its private ownership (Stanford University).

Types of recreation for which area is suitable

If adequately developed, this area would be highly desirable for day use recreation associated with a moderate size body of water including picnicking, small boating and swimming -- health and sanitary considerations permitting. It would not be suitable for extensive aquatic sports such as water skiing. Except under special conditions and arrangements, the use of power propelled craft would be infeasible.

FACTORS INFLUENCING RECREATION DEVELOPMENT

The recreation development of this reservoir will depend upon the amount of land acquired for public use, the facilities installed and the amount of water retained in the reservoir during the main summer recreation season.

San Mateo County has a very active recreation program and operates some seven county parks, ten beaches on the coast side of the peninsula, and several historical sites, totalling about 2,360 acres. In addition, there are two State Parks -- Portola and Butano -- within the county which, combined, include over 2,500 acres. A 1956 publication by the San Mateo County Board of Supervisors states that the above lands plus areas other than city facilities available for recreation purposes within the county totaled 6,029 acres. In addition to these areas, Big Basin Redwood State Park, consisting of over 11,000 acres, is located immediately south of San Mateo County in the County of Santa Cruz but west of the intervening coast range.

There are also several large reservoirs within the county such as San Andreas and Crystal Springs Lakes. However, due to their function of providing sources of domestic water supplies, these bodies of water are not open to public recreation. The existing Searsville Lake, a small reservoir (37 acres) adjacent to and above the proposed San Francisquito reservoir, is about the only inland body of water presently available for general public use. It is commercially operated for recreation.

Population is another factor which has a vital bearing on recreation development at this proposed reservoir. San Mateo County in 1900 had a population of less than 12,000. In 1950 this population had grown to 235,659, 93 percent of which, or 219,387, was classed as urban population. More recent county surveys estimate that as of January 1956, 347,000 persons lived in the county while an estimate made in mid-1958 indicates that this figure has already risen to over 400,000, and is rapidly approaching an estimate of 418,000 projected for the year 1960. In 1956 the county estimated its population would be 690,000 persons by 1990, with a 53.1 percent increase between April 1, 1950 and July 1, 1956. It is already quite apparent this 1990 forecast is much too low.

This phenominal growth in population is not confined to San Mateo County alone, but is also characteristic of the entire San Francisco peninsula from the Golden Gate to the city of San Jose. More especially is it true in the lower two-thirds of this area where there is still much room for expansion. A population progress report prepared by the U. S. Department of Commerce, for the San Francisco District, Corps of Engineers, in October 1958, predicts that San Mateo and Santa Clara Counties will grow most rapidly of those in the Bay Area until 1970. Although San Francisco County is now the most densely populated it is anticipated that by the year 2020, or shortly thereafter, only 900,000 people will reside in that county while 1.3 to 1.5 million people will reside in San Mateo and 3.0 to 3.5 million people in Santa Clara County. Based on the analysis made by the Department of Commerce the U. S. Corps of Engineers estimates that between 14 and 15 million people will live in the San Francisco Bay Area by the year 2020.

This proposed reservoir will be centrally located with respect to this tremendous population center, and will be subjected to public use pressure limited only by the capacity of those facilities which are proposed.

An unusually high economic level prevails in the population area affected, and which would be most directly tributary to the impoundment. This factor can be expected to continue for an indefinite period.

ESTIMATE OF RECREATION NEED AND USE

There can be no question but that the rapid expansion in population which is taking place within the potential service area of this project, with no end of such growth presently discernable, is certain to be reflected in growing needs and demands for recreation outlets in all categories. Increased leisure stemming from shorter work weeks, improved highways and transportation and other related factors only further emphasize this situation.

Included in the growing recreation need is that for day use outlets, for which purpose the San Francisquito impoundment could offer a significant potential. Value in that capacity should preclude consideration for overnight uses or more extended recreation arrangements.

Estimates of the extent to which recreation phases of reservoir utilization can meet the expected demands are predicated upon the following assumptions:

1. That the operation of the conservation pool will be managed with all possible consideration for recreation opportunities. This would involve retention of the conservation pool at or as near the top level as possible during the primary recreation season, i.e. mid-spring through late fall. By this means the conservation waters could be held in reserve for late season use, thus assuring double benefits for the impounded water. The significance of this procedure may not initially be clearly perceived, but growing recreation pressures could, in time, result in wider recognition and keener appreciation of all the true conservation values involved.

2. That adequate land, suitably related to the reservoir, will be reserved for park and/or recreation use, regardless of whether management for this objective may be vested in a public agency or by lease from Stanford University for commercial operation, (as is now the case with Searsville Lake immediately above the project).

3. That facilities for appropriate activities, within the scope and capacity of the project, will be provided.

Based on the above conditions, a visitation of at least 750,000 people a year could be anticipated. In time, it is believed that the number could easily reach as many as one million visitor days annually. It is noteworthy that one 23-acre county recreation area closely related to the same urban populations received no fewer than the former number of visitors in 1958. County representatives active in the recreation field believe that the 750,000 estimate should be considered as minimum.

RECOMMENDED RECREATION DEVELOPMENTS

Initially, minimum basic facilities necessary for access, sanitation, and safety for immediate public use, and for the protection of the project area should be provided. Land to accommodate such developments should be included in the basic right-of-way, and should be sufficient to constitute a workable operating unit or units for management by an administering agency.

Two such basic facility areas for the San Francisquito Reservoir are as follows:

1. The area immediately above the left dam abutment, extending to include the first peninsula above the 300-foot level and back to the presently indicated freeway proposal. This initial area should be provided with access road (from the dam construction road) parking area, potable water, sanitary facilities, fencing, tree planting, and launching facilities for non-motorized small boats. It is estimated that approximately 30 acres should be included in the reservoir right of way for this area.

2. An area on the north side of the reservoir between Sand Hill Road and the reservoir shore west of the secondary dike which will be required for the impoundment. It is estimated that some 50 acres should be reserved here for the balance of the recommended minimum basic facilities. These will involve an access road, one parking area, potable water, sanitary facilities, equipped picnic area, minimum beach facilities, fencing, and adequate tree planting for shade.

Such minimum basic provision for making recreational values inherent in a Federally constructed facility available to the public are considered a justifiable Federal cost.

The extent to which minimum basic facilities are recommended herein is predicated upon two assumptions; namely, first, that reservoir conditions and operations are determined to be favorable, (as noted under "Estimate of Recreation Need and Use"), and second, that the assumption of responsibility for the management and operation of facilities so provided, by a qualified public agency, is assured.

It should be noted that the recreation value of the reservoir can be appreciably enhanced by carefully planned underwater grading for beach and boat areas incident to borrow operations for dam material during construction.

Competent development and management for recreation phases of reservoir utilization would make possible the orderly expansion of developments to the ultimate capacity of this area as justified by need. This expansion can provide extensive picnic areas, including those with barbecue facilities for the accommodation of large groups; requisite parking areas for all activities; foot and horse trails; archery field; very probably an 18 hole golf course; shelters; potable water; adequate sanitary facilities; swimming beach enlargement with related facilities; expanded provision for small boating; seeding and landscaping and, especially, extensive tree planting on the rolling north shore terrain where shade will be needed. The latter program should be initiated by the responsible agency as early as possible and carried on systematically in advance of recreation developments. Trails through the pleasantly wooded, steeper slopes of the south shore would be especially appropriate.

RECOMMENDED LAND ACQUISITION

It is assumed that project acquisition will include sufficient land, (in addition to that indicated above as being requisite to minimum basic recreation facilities) to satisfactorily accommodate foot and horse trails between high water and the boundary, except along the Bear Creek arm of the reservoir north of the Sand Hill Road.

A reservoir right-of-way on the above basis will, however, be entirely inadequate to realize the full park and recreation potential believed to be inherent in the San Francisquito Reservoir area: Therefore, acquisition of the following lands, totalling approximately 190 acres, by the responsible recreation operating agency, is recommended:

1. The balance of the land between the reservoir and the probable freeway location (as presently indicated) on the east side of the reservoir site. Depending on the location of the freeway as finally determined, this could involve some 40 acres.

2. The balance of land bounded by Sand Hill Road on the north, the reservoir boundary line on the south, Bear Creek Inlet on the west and the supplemental dike inlet on the east. It is broadly estimated that this would involve approximately 100 acres, possibly less, depending on the reservoir area boundary as finally determined.

3. Such additional land beyond project acquisition as may be necessary for the protection of the scenically and geologically important steep and well wooded slopes which occur on the south side of the reservoir area. At this time it can only be very roughly estimated that possibly as much as 50 additional acres at most would be necessary to accomplish this objective.

Areas bordering the impoundment on the west, between Sand Hill Road and the Searsville dam, are understood to be presently included in the commercial recreation enterprise associated with Searsville Lake. The area in question, however, borders the extreme upper reaches of the proposed San Francisquito conservation impoundment which will necessarily be subject to the earliest effects of pool drawdown. The recreation value of this reach of the reservoir would, therefore, be more limited than elsewhere.

ESTIMATED COST OF DEVELOPMENT

In the absence of even preliminary development plans which are beyond the scope of this reconnaissance report, only very broad, general development cost estimates are feasible. Such estimates do, however, offer a reasonable indication of what could be involved if circumstances of land acquisition for and operation of the proposed San Francisquito impoundment are conducive to extensive recreation use. These estimates, exclusive of land costs, have been broken down to show the Federal cost of the recommended minimum basic recreation facilities, plus additional development costs. These additional costs are shown as non-Federal expenditures.

Minimum basic recreation facilities

Recommended Federal Costs

Roads (access and circulation)	$ 80,000
Parking areas (2 - 150 cars each)	75,000
Picnic units (50 - with table, grill, waste disposal)	10,000
Sanitation facilities (2 areas)	25,000
Water systems (2 areas)	50,000
Boat dock and launching facilities	15,000
Minimum beach improvement	10,000
Trails, walks, signs and markers	15,000
Conservation landscaping and planting	15,000
Miscellaneous	5,000
Subtotal	$300,000
Additional contingencies, plans and overhead (25% of $300,000)	75,000
Total estimated Federal recreation development cost	$375,000

Expanded recreation facilities

Estimated Non-Federal Costs

Roads (access and interior)	$ 50,000
Sanitary facilities	20,000
Water system	50,000
Parking areas (700 cars)	175,000
Picnic areas (300 units complete)	60,000
Barbecue areas (2 equipped)	20,000
Bath house, with shower & toilet facilities	25,000
Beach and swimming facilities (additional)	15,000
Boating facilities (additional)	10,000
Shelters	10,000
Archery area and facilities	2,000
Golf course, with requisite facilities	520,000
Trails (foot and horse)	20,000
Landscaping (grading, planting and seeding)	25,000
Patrol boat (with spare motor)	7,500
Maintenance equipment (including trucks, tractor, demountable 500 gal. water tank for watering trees, etc.)	20,000
Small equipment (including resuscitator, fire fighting, plumbing, carpentry tools, etc.)	5,000
Miscellaneous	8,000
Subtotal	$1,042,500
Additional contingencies, plans and overhead (25% of $1,042,500)	260,625
Total non-Federal recreation cost	$1,303,125
Rounded to	$1,300,000

ESTIMATED MONETARY BENEFITS

Insofar as it has been deemed feasible to indicate, on a monetary basis, benefits stemming from recreation phases of reservoir utilization, it is estimated that the following annual values can be indicated for the San Francisquito Reservoir:

With minimum basic facilities accommodating an estimated 130,000 visitor days and a benefit factor of $1.60 per visitor day	$ 208,000
With full recreation development and an estimated 750,000 visitor days @ $1.60	$1,200,000

The above figures represent the judgment of the National Park Service as to a reasonable and conservative indication of the recreation benefits accuring to the public as a result of the recreation development and use of this reservoir. They are necessarily conjectural, as they deal with many intangibles that are difficult to evaluate and involve an attempt to foresee conditions that may or may not materialize.

RECOMMENDED PLAN FOR ADMINISTRATION, OPERATION AND MAINTENANCE OF RECREATION USES

It appears to be clearly indicated that the recreation significance of this project is primarily of local significance, and that it warrants county, or comparable, administration. San Mateo County is admirably advanced in the field of park and recreation management and is unusually well qualified to assume such responsibility for this project. County representatives, long familiar with the area in question, have already expressed an active interest in this project and its potential for supplementing the county's public park and recreation area program.

County administration of the recreation phases of this reservoir is therefore recommended.

An alternate possibility might conceivably be worked out. This would involve commercial development and operation on a long term lease arrangement from Stanford University on a basis similar to that presently in force in connection with the much smaller, but very popular, Searsville Lake operation adjacent to what would be the headwaters of the new project. In these circumstances, both operations might be combined under one management. Provision of the minimum basic facilities and acquisition of land requisite thereto at Federal expense could not be recommended in these circumstances.

It is not believed, however, that the above alternate administration arrangement would be in the long-range public interest. While the direct monetary return could conceivably appear more attractive, it is not believed that over-all recreation benefits derived from the project would be comparable to those possible under satisfactory county ownership and operation.

RECOMMENDED FURTHER STUDY AND PLANNING

Additional study of recreation potentials considered herein can only be effected on the basis of firmer data than is presently available regarding actual project sponsor and operation, basic project operation and proposed taking lines for primary project purposes.

March 3, 1849

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE (1-RB)
BUREAU OF SPORT FISHERIES AND WILDLIFE

1001 N. E. LLOYD BLVD.
P. O. BOX 3737
PORTLAND 8, OREGON

ADDRESS ONLY THE
REGIONAL DIRECTOR

PACIFIC REGION
(REGION 1)
CALIFORNIA
IDAHO
MONTANA
NEVADA
OREGON
WASHINGTON

January 12, 1961

Colonel John A. Morrison, District Engineer
San Francisco District, Corps of Engineers
Box 3050, Rincon Annex
San Francisco 19, California

My dear Colonel Morrison:

This is in reply to your letter of December 9, 1960 which requested our comments on your report entitled, "Report of Survey for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California," dated January 1961.

Our preliminary report commenting on this project was submitted to your agency August 12, 1958. The comments and recommendations contained in that letter still apply and are hereby reaffirmed.

Since no minimum pool is to be provided in the reservoir for fish life because of inadequate water supply and limiting economics, fish habitat will be restricted. However, we wish to reemphasize the need for providing public access on land acquired or leased by the Federal Government at the reservoir to maximize fishing and other recreational potentials.

We are returning the report and its appendices to you as requested in your letter. We would appreciate your including copies of both this letter and our letter of August 12, 1958 in your report, Appendix F.

Sincerely yours,

Travis S. Roberts

Regional Supervisor
River Basin Studies

Enclosures.

Exhibit "B"

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
OFFICE OF REGIONAL DIRECTOR
1001 N. E. LLOYD BLVD.
P. O. BOX 3737
PORTLAND 8, OREGON

August 12, 1958

Colonel John S. Harnett, District Engineer
San Francisco District
Corps of Engineers, U. S. Army
Box 3050 Rincon Annex
San Francisco 19, California

Dear Colonel Harnett:

This letter constitutes the preliminary report of the Bureau of Sport Fisheries and Wildlife in relation to fish and wildlife aspects of your Survey Report on San Francisquito Creek.

San Francisquito Creek at the dam site has year-around flow only in the wettest years. During dry years it has flow in only about three months (January 8 through April 1 in 1931). Usually there is some flow (0.1 or 0.2 second-foot) through June. Much, usually all, of the dry season flow is diverted to storage in Lagunitas and Felt Lakes on Stanford University campus for irrigation purposes and is not available for maintenance of streamflow.

With your project floodwaters will be temporarily impounded and controlled and water will be conserved in a multiple-purpose reservoir of 13,100 acre-foot capacity. Of this capacity 8,500 acre-feet will be reserved for flood control, 3,500 for conservation and 1,100 for silt storage. A minimum or dead-storage reservation has not been made. A dead-storage pool will be difficult to maintain because of limitations of water supply.

The proposed dam will rise 100 feet above stream bed and will be of rolled-earth construction. An earth-fill dike will be required in the saddles along Sand Hill Road. Alignment of a proposed state freeway passes over a short northeast arm of the reservoir. If proper timing can be arranged, possible savings in cost and refinements of recreational development may be made possible by construction of the dam concurrently with freeway construction.

The National Park Service is preparing a report on the possibilities of recreational development at this reservoir. County agencies and other local interests have expressed interest in operation

1145 800.922 - San Francisquito

of the conservation pool in such manner as to achieve maximum recreational benefits. However, plans for conservation distribution works and operation of the reservoir have yet to be worked out.

The California Department of Fish and Game believes that the reservoir has a great potentiality for management as a combined warm-water fishing lake and recreational area. Preliminary impressions of the National Park Service also are favorable. It appears obvious that needs of the surrounding area will dictate full recreational development, although such use will be in conflict to some extent with existing uses of the southern edge of the area.

Small runs of steelhead trout utilize San Francisquito Creek. Most of the important remaining spawning area for this species will be cut off by the proposed dam. A small diversion about 1.4 miles downstream, which diverts water to Lagunitas Lake, is provided with a fish ladder. The 1.4 mile of San Francisquito Creek and Los Trancos Creek, a tributary entering just above the diversion, will remain open to use by steelhead. Flows available for rearing steelhead trout will be severely reduced by the project. In order to partially mitigate the loss of steelhead trout producing area, every effort must be made to insure maximum recreational development of the reservoir area for public use.

Wildlife habitat supporting both game animals and species of interest only to naturalists and biologists will be destroyed with the project.

The Jasper Ridge area which adjoins the reservoir site on the south has for many years been set aside by Stanford University as a reserve for faunal, floral and geological studies. This area contains plant and animal communities unique to the region. Through the years, the University has conducted numerous scientific studies in this area. The proposed reservoir will inundate and destroy parts of the preserve. Thus, segments of the unique ecological assemblage in the area will be eliminated.

The reservoir area is closed to hunting so that probably no loss of harvest is involved. No means are available for compensating the loss of habitat.

Please keep us informed of the status of your planning on this project so that we may provide you with a more detailed appraisal of project plans as they are developed.

From our reconnaissance study it is recommended that:

1. You cooperate to the fullest extent possible with the California Department of Fish and Game and the Bureau of Sport Fisheries and Wildlife in formulating plans for management of the project in the interests of fish life.

2. Lands required for the reservoir be acquired in fee insofar as possible to assure the highest public use of the reservoir for fishing and other types of recreation.

These comments have the concurrence of the Bureau of Commercial Fisheries.

Your soliciation of our comments in the early stages of your planning is appreciated.

Sincerely yours,

J. J. Barnaby

Acting Regional Director

ADDRESS ALL
COMMUNICATIONS TO
THE REGIONAL DIRECTOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGIONAL OFFICE, REGION 2
P. O. BOX 2511
SACRAMENTO, CALIFORNIA
(TOWN AND COUNTRY AREA)

IN REPLY
REFER TO: 2-710

DEC 28 1960

District Engineer
U.S. Army Engineer District, San Francisco
Corps of Engineers
Box 3050, Rincon Annex
San Francisco 19, California

Sir:

As requested in your transmittal letter of December 9, 1960, I am returning the copy of your Report of Survey For Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California, dated January 1961 (File SPNGP).

San Francisquito Creek near its mouth borders on Santa Clara County which the Bureau of Reclamation has under investigation for water service. However, I have noted that your proposed works do not interfere with our study of the Santa Clara County area. In view of this, I have no other comment.

Thank you for the opportunity to comment on your report and for keeping us informed on your investigation.

Sincerely yours,

EF Sullivan

E. F. Sullivan
Acting Regional Director

Enclosure

Exhibit "C"

UNITED STATES
ATOMIC ENERGY COMMISSION
SAN FRANCISCO OPERATIONS OFFICE

2111 BANCROFT WAY
BERKELEY 4,
CALIFORNIA

IN REPLY REFER TO:

E:EJC

December 29, 1960

Colonel John A. Morrison
District Engineer
U. S. Army Engineer District, San Francisco
Box 3050, Rincon Annex
San Francisco 19, California

Dear Colonel Morrison:

In accordance with your request of December 9, 1960, we have reviewed the advance copy of Report of Survey for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California, dated January 1961.

Based on the information available to us, our review indicates that it is possible from an engineering viewpoint to make the accelerator and reservoir projects compatible with each other. Because of the proximity of the accelerator to the reservoir, the construction and operation of the accelerator will be somewhat more complicated.

In connection with the following points, minor modifications may be required in your "Report of Survey":

1. The borrow material area for the dam construction is, in part, in an area to be occupied by the accelerator.
2. A recommended recreational area is indicated which may not be compatible with the accelerator.
3. A minor reduction in the reservoir capacity will result from the accelerator construction.
4. The land acquisition costs may change since a part of the land to be occupied by the reservoir is the same land which is to be occupied by the accelerator. Further, we suggest that the land appraisal values used are low.

Exhibit "D"

5. The alignment for the Junipero Serra Freeway Route as shown in your report differs from that given us in our discussions with the Division of Highways.

We suggest that as the designs for the accelerator are developed we schedule joint meetings to resolve any design features which may be of mutual concern. Prior to the construction of the reservoir, similar conferences will likewise be necessary.

We have given these comments based on the compatibility of the two projects from an engineering viewpoint and this letter is not intended in any way to serve as an endorsement of the project covered in your report.

We have retained one (1) copy of your report for our files and future reference.

Sincerely yours,

J. E. Armstrong, Director
Engineering Division

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

January 13, 1961

PUBLIC HEALTH SERVICE
447 Federal Office Building
San Francisco 2, California

Colonel John A. Morrison
District Engineer, Corps of Engineers
U. S. Army Engineer District, San Francisco
180 New Montgomery Street
San Francisco, California

Dear Colonel Morrison:

Enclosed please find our report on the "Public Health Aspects of the Survey for Flood Control, San Francisquito Creek, Santa Clara & San Mateo Counties, California" which we have prepared in accordance with your letter dated December 9, 1960.

Your cooperation in keeping this office informed on the progress of this project will be greatly appreciated.

Sincerely yours,

Wm B Schreeder

Wm. B. Schreeder
Sr. Sanitary Engineer
(Water Supply & Pollution Control)

Exhibit "E"

REPORT
on the
PUBLIC HEALTH ASPECTS
# of the
SURVEY FOR FLOOD CONTROL
SAN FRANCISQUITO CREEK
SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA

for

THE CORPS OF ENGINEERS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO

prepared by

THE U. S. PUBLIC HEALTH SERVICE

DEPT. OF HEALTH, EDUCATION, & WELFARE

REGION IX - SAN FRANCISCO, CALIFORNIA

January 1961

E-2

PUBLIC HEALTH ASPECTS
# of the
REPORT OF SURVEY FOR FLOOD CONTROL & ALLIED PURPOSES
SAN FRANCISQUITO CREEK, SANTA CLARA & SAN MATEO COUNTIES, CALIFORNIA

INTRODUCTION

In accordance with the policies and procedures of the Federal Inter-Agency Committee on Water Resources, this office has reviewed the"Report of Survey for Flood Control & Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California" as requested by the Corps of Engineers. In reviewing this report, the Public Health Service has requested and received the comments of the California Department of Public Health, the County Health Departments and our vector control specialists at Greeley, Colorado.

The San Francisquito Creek drainage basin is approximately 45 square miles in area and is located on the easterly slope of the Santa Cruz mountains at the sourthern extremity of the San Francisco Peninsula. The creek flows through a highly urbanized area to enter San Francisco Bay some 25 miles south of San Francisco.

The proposed dam would be a rolled-earth structure, with a length of about 2,200 feet, with the crest rising 100 feet above streambed. The multiple purpose reservoir would have a gross storage capacity of some 12,600 acre feet.

SANITARY ENGINEERING

Water Supply

It is stated that 3,500 acre-feet are to be held as storage for municipal and industrial water supply purposes. With the turbidity, color, and possible pollution resulting from watershed usages for agriculture, housing, and commercial activities, complete treatment will be required of surface water taken from the proposed new reservoir for domestic water supply. This treatment should include provisions for flocculation, sedimentation, pre-chlorination, filtration, and post-chlorination prior to delivery to any municipal distribution system. Turbidity from high stream flow will carry over by short-curcuiting during periods when the reservoir is spilling over the crest. In addition, the water discharged from the proposed outlet will have a low dissolved oxygen content. The low dissolved oxygen content of the discharge will act as an organic pollutant by lowering the net dissolved oxygen content of the receiving stream. The advisability of utilizing an intake capable of withdrawing water from various reservoir levels to compensate for the varying water quality is strongly recommended. This would be of some aid in obtaining the best available quality of raw water.

Sewage Disposal

Because the project area is generally urbanized, waste disposal is by the municipal disposal system. The project will be beneficial for sewage disposal as it will reduce the danger of flood damage to sewage works.

Sanitation

Adequate measures should be developed to periodically inspect and clean any channels in the system. During construction, provisions should be made for adequate sewage and trash disposal facilities for construction personnel. All debris from any clearing and grubbing, waste construction materials, etc., should be disposed of in accordance with local regulations.

VECTOR PROBLEMS

Encephalitis, commonly referred to as "brain fever", is the mosquito-borne disease of most concern. Surveys of the mosquito fauna in the area show that Culex Tarsalis and Culex quinquefasciatus are prevalent in the area. Both species are considered to be primary vectors of encephalitis. The vicious-biting Aedes mosquito may create a public health problem not involving transmission of specific diseases. These mosquitoes may seriously interfere with healthful outdoor activities of adults and children during the summer months. The City of Palo Alto and Stanford University are within easy flight range of these mosquitoes.

Excessive numbers of mosquitoes also cause severe economic losses by lowering meat and milk production, by reducing the efficiency of agricultural and industrial workers, and by lessening the value of real estate.

RECOMMENDATIONS

1. Borrow areas resulting from construction of the reservoir should be made self-draining.
2. All depressions which will be flooded by the reservoir at maximum pool level and which will retain water when the reservoir pool recedes should be made self-draining or filled.
3. Vegetation and debris should be removed periodically from all mosquito control basins.
4. Adequate provisions should be made to maintain the floodways and river channel free of obstructions and ponding areas.
5. Funds should be made available for maintenance work required to eliminate mosquito sources associated with the watershed project.

GENERAL

Generally, the reduced flood danger should lead to a safer environment. However, the following additions to planned facilities are recommended: Warning signs should be placed at all dangerous facilities; precautions, as necessary, should be taken to avoid the development of any man-made hazards to the safety and well-being of employees, residents, or construction site visitors.

It is further recommended that the County Health Departments, the California Department of Public Health, and the Public Health Service be kept currently informed of any changes in proposed project.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

2020 Milvia Street
Berkeley 4, California

January 9, 1961

Colonel John A. Morrison, District Engineer
U. S. Army Engineer District, San Francisco
Corps of Engineers
180 New Montgomery Street
San Francisco, California

Dear Colonel Morrison:

This is in reply to your letter of December 9, 1960, transmitting an advance copy of your Report of Survey in the interest of flood control and allied uses on the San Francisquito Creek, San Mateo and Santa Clara Counties, California.

The watershed and, more particularly, the area served by the San Francisquito project is rapidly changing from agricultural to urban-industrial type of development. There are no soil conservation districts serving the watershed and no contemplated program of this Service within the watershed boundaries.

We are aware, however, of the real need for flood prevention on San Francisquito Creek and for the supplemental water supply to be developed in this part of Santa Clara County.

We appreciate an opportunity to review this advance copy of your Report of Survey and its Appendix "A". Both are returned herewith in accordance with your request.

Sincerely yours,

John S. Barnes
State Conservationist

By E W Sayler
E. W. Sayler, Acting

Attachments - 2

Exhibit "F"

ARIZONA
CALIFORNIA
NEVADA
HAWAII

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
REGION SEVEN

California Division
07-04

P. O. Box 1915
SACRAMENTO 9, CALIFORNIA

December 16, 1960

Colonel John A. Morrison
District Engineer
U.S. Army Engineer District, San Francisco
Corps of Engineers
180 New Montgomery Street
San Francisco, California

Dear Colonel Morrison:

Your letter of 9 December 1960 (File SPNGP) transmitted for the review and comment of this office an advance copy of your report of survey scope for flood control and allied water uses on San Francisquito Creek, San Mateo and Santa Clara Counties, California.

Our letter of July 2, 1958 to your office had called attention to apparent conflicts between your proposed project and two Federal-aid Secondary highways on Whiskey Hill Road and Sand Hill Road, and also Interstate Route 91 (now Interstate 680).

We note from Pages 23 and 33 and Plate 2 of your report that the Federal-aid Secondary highways are to be protected by dikes in portions and will be relocated or raised in other portions, and that the cost of this work is to be assumed by the reservoir project. Our discussions with State Division of Highways have indicated that increased costs to the Interstate freeway due to the reservoir are expected to be minor.

Inasmuch as your office is coordinating your design with the local agencies directly responsible for the Federal-aid highways involved, Public Roads' interests appear fully satisfied.

In accordance with your request the advance copy of your report is being returned herewith.

Very truly yours,

J C Bacon

For D. J. STEELE
Division Engineer

Enclosure - 1

Exhibit "G"

EDMUND G. BROWN
GOVERNOR

WILLIAM E. WARNE
DIRECTOR

ADDRESS REPLY TO
P. O. BOX 388 SACRAMENTO 2
1120 N STREET HICKORY 5-4711

STATE OF CALIFORNIA
Department of Water Resources
SACRAMENTO

January 23, 1961

Colonel John A. Morrison, District Engineer
U. S. Army Engineer District, San Francisco
Corps of Engineers
Box 3050, Rincon Annex
San Francisco 19, California

Subject: Your File No. SPKGP

Dear Colonel Morrison:

This is in reply to your letter of December 9, 1960, which transmitted advance copies of your "Report of Survey for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California", for review and comment by interested state agencies.

The following comments of the state agencies concerned are submitted for your consideration. The Division of Soil Conservation, Department of Natural Resources, reviewed the report and had no comment to make. For sake of brevity, your report will be referred to as the San Francisquito Report.

Department of Water Resources

The San Francisquito Report was prepared under the provisions of the Flood Control Act of 1941 (Public Law 228, 77th Congress), which authorized a preliminary examination report. Subsequent to review of the examination report, the Chief of Engineers, on June 6, 1945, authorized a survey report on San Francisquito Creek.

The selected plan of improvement consists of an earthfill multipurpose dam and reservoir with gross storage capacity of 12,600 acre-feet, to be located about 2.5 miles downstream from existing Searsville Lake; 8,500 acre-feet of storage capacity would be allotted to flood control, 3,500 acre-feet to conservation, and the balance of 600 acre-feet reserved for silt accumulation.

Exhibit "H"

As an alternative to the reservoir, consideration was given to enlarging the existing channel to a capacity sufficient to accommodate flood flows. The plan for the enlarged channel would be more costly than the proposed reservoir plan, largely because of excessive right of way costs for the enlarged channel.

The reservoir of the selected plan would provide a firm yield of about 1,500 acre-feet of water annually for delivery to the City of Palo Alto, and conservation benefits were based on this amount. This yield would supplement the city's present supplies from local wells and from the Hetch Hetchy System of the City and County of San Francisco.

The total project cost is presently estimated to be $7,754,000, of which $4,112,000 will be borne by the Federal Government and $3,642,000 charged to local interests. The local share is comprised of a cash contribution of $2,354,000 to cover the cost of lands, easements, and rights of way and relocations of utilities allocated to flood control, plus an amount of $1,288,000 covering the cost of the water supply function, to be repaid with interest over a maximum period of fifty years. The total annual benefits resulting from the proposed project are estimated to be $581,500, compared to annual costs of $380,000. The resulting benefit-cost ratio is 1.5 to 1.0. Considering the benefits and costs allocated to conservation and flood control separately, the benefit-cost ratios are 1.1 to 1.0 and 1.6 to 1.0, respectively.

The San Francisquito Report shows the total construction cost of the dam and reservoir, excluding administration and engineering costs, to be $4,397,000. Our review of the detailed cost estimate, based on prices for similar work in the vicinity of the proposed project, indicates that several of the unit prices are significantly low. Average bid prices for 13 bids on the recently completed Newell Creek Project near Santa Cruz were used as a basis for comparison.

The following table summarizes the differences between our estimate and that shown in the report.

Item No.	Item	Quantity	Unit	Unit price		Increase
				Report estimate	DWR estimate	
Main Dam						
7.	Stripping	189,600	C.Y.	$ .40	$ .80	$ 75,600
8.	Excavation for core	9,800	C.Y.	.75	.90	1,500
9.	Embankment in place	1,793,700	C.Y.	.60	.70	179,400
Spillway						
15.	Stripping	27,300	C.Y.	.40	.80	10,900
16.	Excavation, common	156,800	C.Y.	.40	.80	62,700
19.	Concrete, reinforced	9,600	C.Y.	44.00	54.00	96,000
23. & 40.	Fence, 4' chain link	2,420	L.F.	2.50	3.50	2,400
Outlet Works						
30.	Concrete, reinforced	1,200	C.Y.	60.00	75.00	18,000
Closure Dike						
42.	Stripping	2,300	C.Y.	.40	.80	900
43.	Embankment in place	49,600	C.Y.	.75	.90	7,400
			Subtotal			$454,800
			Contingencies @ 13%			59,200
			TOTAL			$514,000

It is believed that an upward revision of the unit prices indicated would result in a more accurate estimate of the cost of construction. The revised total project cost would be $8,268,000, and based on your ratios of the allocated capital costs, $4,541,000 would be borne by the federal government and $3,727,000 would be borne by local interests. The local cash contribution would be unchanged at $2,354,000. The cost of the conservation feature, to be repaid by local interests, would become $1,373,000. Annual cost of the project would increase from $380,000 to $400,000 including pre-authorization studies.

In reviewing the economic feasibility of the San Francisquito project, we note what appears to be a significant error in paragraph C-38 of Appendix C, "Plan of Improvement, Cost Estimates and Cost Allocations". The separable cost of flood control is computed using the annual conservation benefit rather than the annual cost of the single-purpose conservation reservoir. The resulting incorrect value is used in paragraph C-39 to determine the allocation of annual project cost between flood control and conservation. Correction of this error results in an increase of about $40,000 in the allocation to water conservation, and a like reduction in the allocation to flood control. After adjusting the annual costs involved to reflect the increased cost items discussed above, the revised allocation to water conservation becomes approximately $117,000, with approximately $280,000 allocated to flood control. Respective benefits, as stated previously, are $79,500 and $502,000 annually.

In accordance with this department's established policy regarding economic analysis of multipurpose projects, we have allocated project costs using the Separable Costs-Remaining Benefits Method. Using our suggested increased costs, the resulting allocation to water conservation by this method is about $79,000. By comparison with benefits based on the Hetch Hetchy System as an alternate source, the water conservation feature has a benefit-cost ratio of essentially 1.0 to 1.0.

The report states that the cost of bringing into the San Francisquito Creek Basin a limited supply of water from outside sources, other than the presently developed Hetch Hetchy System, is not feasible at this time. However, a report on "Supplemental Water Supplies for North Santa Clara Valley and Related Service in San Benito and Santa Cruz Counties", prepared by Samuel B. Morris and S. T. Harding, Consulting Engineers, in December 1960, sets forth feasibility considerations and costs of supplying water to Palo Alto from the South Bay Aqueduct. In that report, based upon an annual over-all delivery of 88,000 acre-feet of water, as recommended in the report, the total cost of treated water delivered to Palo Alto is given as $39.15 per acre-foot. Recent studies by this department, based upon more conservative estimates of the cost of distribution and water treatment, indicate that South Bay

Aqueduct water can be delivered to Palo Alto in fulfillment of expected demands at a cost of approximately $51.00 per acre-foot by the year 1966. Prior to that time, between 1962 and 1966, costs would be approximately $57.00 per acre-foot, due to the use of a temporary means of conveyance.

It appears from the foregoing that the South Bay Aqueduct constitutes a potential and less expensive alternative source of supply for Palo Alto, and that evaluation of the conservation feature of the proposed project should be made in the light of probable costs of water from that source. On the basis of data included in the San Francisquito Report, and with the benefits which would be indicated if the South Bay Aqueduct were considered to be an appropriate alternative source, we have allocated annual costs by the Separable Costs-Remaining Benefits method, again using the suggested increased costs. This analysis indicates that the separable cost of the water conservation function would be about $96,000, including costs for treatment and transmission. This amount, which does not include any of the joint costs, is more than the benefits of $76,500.

It would appear from our analysis that the conservation feature, by comparison with the Hetch Hetchy System, is only barely justified, and by comparison with the cost of water from the South Bay Aqueduct is not economically justified. Consequently, the desirability of its inclusion should be considered further. There is little doubt that the water could be integrated into the Palo Alto system and marketed at a rate sufficient to repay the conservation costs. The city would need to weigh the desirability of obtaining water from this source, as compared with eliminating the conservation function and relying upon the delivery at some time in the future of water from the South Bay Aqueduct.

In the event the conservation feature continues to be considered, the probable effect upon the Hetch Hetchy System of a reduction in demand on the part of the City of Palo Alto for its available or planned water supply, and probable increased unit costs to the City of Palo Alto because of the decreased requirement from that source, should be analyzed.

Department of Fish and Game

This department has reviewed the "Report of Survey for Flood Control and Allied Purposes, San Francisquito Creek" and related appendixes transmitted to us with your letter of December 15, 1960.

This letter constitutes our reply to your request for comments for inclusion in the State's report and our report to the Corps of Engineers under the provisions of the Fish and Wildlife Coordination Act (Public Law 85-624).

Since the Corps of Engineers has concluded that no minimum pool will be provided for fish and game enhancement or for recreation, there is little necessity for development of further plans in this regard or for special fish and game management considerations.

It is specifically recommended that all federally owned or federally purchased project lands be open to free public access for recreation purposes.

Division of Highways

This refers to your communication of December 16, 1960, forwarding for review and comments the proposed report of the U. S. Army Corps of Engineers on Survey for Flood Control and Allied Purposes, San Francisquito Creek, Santa Clara and San Mateo Counties, California.

The proposed dam and reservoir will not seriously conflict with existing or planned state highways in the area.

We wish to point out that the present alignment of State Highway route 239 differs slightly from the alignment shown in the report. The present alignment can be obtained from this division.

Summary

In summary, it is believed that the estimated construction cost of the dam and reservoir may be about ten percent low. It is also believed that there is a serious question as to the economic justification for the inclusion of conservation storage in the reservoir. There is no question, however, regarding the need and justification for the flood control storage proposed.

The foregoing comments are subject to such revision as may be considered advisable upon receipt by the State of California of the proposed report of the Chief of Engineers. The opportunity to review the draft report is very much appreciated. Advance copies of the report are being returned to you under separate cover.

Sincerely yours,

William E. Warne

Director

Encl.
1 original
9 copies

SANTA CLARA COUNTY
FLOOD CONTROL AND
WATER DISTRICT
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